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"Contemporary Education" is a magazine, published six times a year, which seeks to present competent discussions of contemporary trends and problems in education. This issue concentrates on the computer's role in education, with the conviction that the computer will transform education and eventually inform and pervade all areas of human activity, and that its potential is limited only by the resourcefulness of the user. There are eight articles on computer-assisted instruction (CAI). Other contributions include book reviews, an article on ERIC, and other miscellaneous items on education. (GO)

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CONTEMPORARY EDUCATION

Contemporary Education (Formerly the Teachers College Journal) is published by the School of Education, Indiana State University. It seeks to present competent discussions of contemporary problems in education and toward this end generally restricts its contributing personnel to those of preparation and experience in the field.

Manuscripts concerned with controversial issues are welcome, with the express understanding that all such issues are presented without editorial bias or discrimination, providing that manuscripts were accepted and approved without qualification by the editorial associates and the editor.

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ACKNOWLEDGEMENTS: Major credit for this issue goes to the Indiana State University interdisciplinary Ad Hoc **Computer-Assisted Instruction Committee**. Professors John O. Conaway and David A. Gilman were especially instrumental in soliciting appropriate manuscripts. Junior Proofreader Carol Nelson, Senior Proofreader Jane Angell and Assistant Editor Becky Edwards are commended for their usual diligent efforts.

Guest Editorial . . . .

During the Christmas Holidays of 1968, the world witnessed the successful completion of a dream of man. This was the spectacular space flight from Cape Kennedy to the moon and its return. From the day the countdown was started, in checking out the space craft and all of the facilities which insured the success of this mission, one word seemed to dominate the news reports. This word was *Computers*.

In the control center at Cape Kennedy, all of the systems on the space craft were checked continuously by computers. At the Houston, Texas Space Center all of the navigational and communications equipment was sensed and recorded by computers. On board the space craft, the crew had available a complete computer system.

This trip to the moon and the return was computer-controlled and directed, from the development of the designs for the parts to construct the rocket to the completion of the mission. The computers will be utilized for months to analyze and evaluate all of the data which resulted from this flight.

This illustration was used to make us realize that our society is rapidly becoming computer-assisted. Very few areas of our lives today are not affected by these amazing machines which appeared on the commercial market about 15 years ago. The acceptance by business, industry, science and government of the high speed digital computer, unlike many other technical achievements, has been remarkably favorable. Already, the computer is used to schedule and control the production of vast steel mills and other manufacturing plants, to train leaders of business, and to check income tax returns, to mention only a few.

The computer's capability is limited mainly by the resourcefulness of its user and is viewed by some as the most potentially dynamic force for meeting the rapidly changing needs of society.

What does this mean for educators? It means that unless the high schools and colleges start telling their students how their lives and work will be changed by computers, they are selling the high school student short. A report from the President's Office of Science and Technology on the use of computers in higher education has suggested that any four-year liberal arts college that does not give students experience in data processing techniques has severely cheated its graduates educationally. It is further suggested that the high school which ignores the impact of computers is just as obsolete.

These new technologies are knocking at the school house door, and computers are beginning to have a powerful impact on all educational fronts. Many educators are firmly convinced that within the next few years we will see these remarkable instruments, the computers, bring about a revolution in the classroom and in the entire educational process. This will be equivalent to the one already wrought by computers in science and industry.

John O. Conaway

Professor of Industrial Education

Indiana State University

The Advent of the Educational Heart Transplant, Computer-Assisted Instruction: A Brief Review of Research

By John Feldhusen and Michael Szabo

IF THE teacher is the heart of the classroom, then surely Professors Suppes and Atkinson have performed one of the first transplants in the field of education. Dr. Barnard was forced to settle for a live human heart transplant, perhaps without hope of an artificial heart transplant for many years. Professors Suppes and Atkinson work in a more advanced field in which an artificial teacher is already available, so a live transplant is unnecessary. The artificial educational heart, the IBM 1500 - 1800 instructional system is the available educational heart. One live heart transplant may cost up to $50,000. One livewire computer is apt to cost more. But the business of human heart transplants is here to stay and to be perfected. So is computer-assisted instruction.

* * * * * *

Perhaps the major new educational development of the late 50's and early 60's was the teaching machines and programmed instruction (PI) movement which grew out of the work of B. F. Skinner (1968). Correspondingly the major development of the late 60's and early 70's will undoubtedly be the computer-assisted instruction movement. The latter grows directly out of the PI movement, and the transition is well documented in Glaser's **Teaching Machines and Programmed Instruction: Data and Directions** (1965). This volume provides a distillation of PI research and points the way to CAI in a chapter by Stolurow and Davis (Chapter 5) and another chapter by Lewis and Pask (Chapter 6). Knowledge distillates of the PI movement, especially relating to the production and use of programs, are also well documented in the 66th Yearbook of the National Society for the Study of Education, Part II, **Programmed Instruction**, edited by Lange (1967).

Instructional use of computers refers to all of the ways that computers are used to bring about learning. However, this review limits the concept of computer-assisted instruction to those pedagogical activities in which the computer communicates with the student via natural language and/or figural and symbolic information in on-line, interactive instructional events. The major types of CAI at present which fit this definition include (1) didactic instruction in which linear or branching programming techniques are used (e.g., Coursewriter), (2) tutorial dialogues in which the student is relatively free to query the computer (e.g., ELIZA), (3) inquiry approaches in which the student attempts to explain a phenomenon by using the computer as a resource tool to seek necessary information (e.g., REPLAB on PLATO), (4) gaming or problem-solving in which the student is led into a simulation of some real life problems and in which the computer controls the sequence and nature of simulated events (e.g., Wing's Sierra Leone game).

Our review of research will cover the following topics:

1. Major reviews of CAI research.
2. Basic learning studies.
3. Comparative studies.
4. Research on individual differences.

JOHN FELDHUSEN, *Professor and Chairman, Educational Psychology Section, Purdue University.* MICHAEL SZABO, *Graduate Student, Purdue University.*

Major Reviews of Research

Hickey's review (1968) of the CAI literature is a milestone accomplishment in this field. The long delay in publication is more than compensated for by the thoroughness of the review. This review offers an excellent overview of CAI developments in the U.S. and abroad, and it provides descriptions of current CAI applications, the major centers of CAI activities, CAI systems and language development, in addition to the review of CAI research and theory development.

Gentile's review (1967) of "The First Generation of Computer-Assisted Instructional Systems" provides an excellent theoretical and evaluative commentary on existing systems and attention to the theoretical connections with the PI movement. Because the research on PI proved to be so inconclusive on major points of theory, Gentile concludes that there is no durable theoretical base for PI or CAI. He also cautions that principles of PI programming may not readily transfer to CAI. Gentile concludes that at present practically all CAI support funds go into the development of systems, equipment, and courses, not into research on learning via CAI, which is needed most.

Regan (1967) reviewed various aspects of the CAI movement and concluded with the question "Where is CAI and where is it going?" First he suggests that many educators and researchers have strong misgivings about both the current state and future developments of CAI. In particular there is the great concern about the supposed impersonal and mechanistic nature of CAI. However, he concludes by agreeing with Christal (Office of Naval Research, 1965) that the real issue may be whether we can deny students the effective attention and assistance available through the use of computers.

Bushnell (1965) reviewed research programs in CAI. He sent a questionnaire to researchers in the field and summarized their responses. For a number of reasons, notably because of the magnitude of hardware installation and because the systems approach is so often used, CAI research is usually part and parcel of the system development and application process. This is to say that CAI research will not be possible for random small research activities here and there as has been the case for much educational research. Instead the research is concentrated at centers, is closely tied to systems development, and is programmatic, systematic and coordinated. For the present, however, it also seems likely that CAI research will be overshadowed by systems development efforts.

Comparative Studies

Stolurow (1962) deplored efforts in PI research to compare teaching machines or programmed instruction with a live teacher or traditional instruction because the latter may be extremely difficult to specify instructionally. Thus, we might be comparing one set of variables in PI with a quite different set in TI. Recently, Reynolds (1968a) echoed Stolurow's warning and added a warning that evaluation of media outside of their applied context and outside of a theoretical system may yield little information. Feldhusen (1963) pointed out, however, that the very thing which school people may want to know is how well the new method works in comparison with what they are doing. In truth, there are two fundamental problems, if not more, in comparative studies. First, the objectives must be specified and **must** be the same for two or more methods about to be compared. There is no point in comparing things designed for different ends. Secondly, it is essential, as Lumsdaine (1963) pointed out, that the instructional events be specifiable and reproducible. There is no point in comparing pigs in pokes. We must be able to look directly at the pigs.

Many or most new instructional programs for CAI undergo some comparative evaluation with traditional or on-going methods of instruction. The sample that follows may be merely illustrative.

Axeen (1967) developed and evaluated a program on how to use the library employing the PLATO system. She concluded that use of the library could be taught with CAI. CAI and TI students both made significant gains, but the difference between groups was not significant. Students learned faster on CAI, PLATO lessons took much more time to prepare than TI lectures, and subsequent use of PLATO instruction saved time as compared with TI.

Ash and Moller (1967) programmed a unit of material on terminology and concepts in modern mathematics and administered it to 16 college sophomore Ss on CAI in approximately two 45-minute sessions while 16 Ss received live classroom instruction on the same material. While the CAI Ss had a higher mean on the posttest than the controls (25 vs. 23), the difference was not significant. Attitudinal evaluation showed 30 percent of the CAI Ss favored CAI over traditional teaching, 27 percent were neutral, and 43 percent favored traditional lectures and discussions.

Bitzer (1966) studied the use of PLATO for instruction in clinical aspects of medical-surgical nursing. Seven freshmen in nursing were taught with a CAI inquiry program while seven received live clinical instruction. The mean posttest score for the CAI Ss was 26, for the control group, 23, and the difference was significant at the .09 level. Student attitudinal evaluation revealed that the following were perceived advantages of CAI: (1) active participation, (2) individual rates of progress, (3) immediate feedback, and (4) simulation of work with patients.

Schurdak (1967) studied the effects of a CAI program, a programmed text, and a conventional textbook-workbook combination in teaching Fortran programming to 48 college students, 16 per treatment. The CAI group scored significantly higher than the other two groups.

Schwartz and Haskell (1966) used a CAI program for training electronic technicians in basic data-processing. A standard PI for the same purpose was already in use. The PI was used with 79 Ss and the CAI with 25 Ss. Posttest means did not differ between groups. However, the time to complete the program for the CAI groups, 22 hours, was significantly less than for the PI group, 25. Both groups saw the method, PI or CAI, as about equal to regular classroom instruction for learning and interest.

Schwartz and Long (1967) compared a self-study program on introduction to computers with a CAI program on the same subject. Forty IBM field engineers served as Ss, 16 on self study and 24 on CAI. The difference between the mean performances of the two groups on the posttest was judged to be of no practical significance, but CAI Ss took significantly less time in the training as a whole. All students in both groups had been exposed to CAI, and overall they indicated a preference for CAI over self study.

Quinn (1966) used a CAI program designed to teach reading in grades 5 to 7 with eleven children for approximately 3 hours. As a base for comparison of program effectiveness, he used national norms on the Gates Reading Survey. The mean increase in reading ability was 1.1 years. The children were unanimously favorable to CAI, and their motivation to learn remained high.

Quinn (1967) also developed arithmetic instructional material for 5th and 6th graders. There were 57 experimental Ss and 57 controls who received no special instruction. Experimental Ss had ten 40-minute sessions at the terminal. Criterion tests for the basic arithmetic skills were administered. CAI Ss achieved significantly more than control Ss only on the multiplication subject.

O'Neal (1968) summarized IBM's Field Engineering CAI applications research during 1967. Six training areas were studied and eleven separate projects were run evaluating posttest performance, time to complete, and attitudes. Significant differences were found in favor of CAI in time to complete three of the courses and in attitudes toward two of the courses.

Feldhusen and Chavers (1968) reported results on the use of CAI to teach graduate students in teacher education the Flanders classroom interaction analysis system. The program was in tutorial form written in Coursewriter language and took two to three hours per student. Slides were used in addition to keyboard i/o. CAI students were superior on a constructed-answer posttest to self-study students who used a specially prepared manual and controls who received no instruction. Attitudes toward CAI were highly favorable.

Adams, Morrison and Reddy (1967) described a CAI language laboratory designed to teach speaking, understanding, reading and writing in a first year college German course. Preliminary evaluations provided no data on student achievement but indicated that the program was regarded by the instructor and students as successful functionally. In a later report by Morrison and Adams (1967), evaluative data were reported which indicated that students in the CAI German program, when compared with a class taught by a live instructor who used the audio-lingual method and a language lab, scored higher on a writing achievement test at the end of the first semester, but there were no significant differences between the groups at the end of the second semester on tests of speaking, listening, and reading.

Filep and Murphy (1967) described the development and evaluation of a computer-assisted learning (CAL) system for in-service education of high school biology teachers. Teachers used the terminals before and after the normal school day and on weekends. CAL teachers (N=23) were compared with an uninstructed control group of 11 teachers. The CAL group outscored the controls on three achievement tests, and it was concluded that the attitude of the CAL group toward the innovation was favorable.

Grubb and Selfridge (1962) reported a pioneering research on the use of CAI in teaching psychological statistics. Six students received CAI, eight received lectures, and eight programmed texts. The CAI group took 5.3 hours, the lecture group 49 hours (?), and the programmed text group 12.2 hours. Comparative achievement data were available only for the CAI and lecture groups. The results indicated that the CAI group outperformed the lecture group.

Wing (1966, 1967) reported research on three games which were designed to teach economics concepts. In the Sumerian game the S is a king-priest in 3500 B.C. facing economic problems in his kingdom. In the Sierra Leone game he is an AID officer required to give economic advice to local administrators. In the Free Enterprise game he runs a toy store and later a toy factory. Twenty-six 6th graders did the first two games on the computer while 24 were taught with a live instructor. He concludes that 6th graders can play the games on CAI, they enjoy it even up to 15 hours on the terminal, and they learn as well as with a live teacher but take less time.

A number of other studies also yielded comparative data but are not included here because they also yield basic data about learning processes. Thus, they are included in the next section.

Basic Learning Studies in CAI

By basic research in CAI we mean either of two types of research. The first is concerned with basic variables in CAI as such. Thus, the researcher might be concerned with types of reinforcement in CAI. The second is concerned with basic learning phenomena, regardless of the instructional media. The better research in CAI will yield results which generalize across media and methods. The research which is described next is essentially of the first type.

Keats (1968) tested the effectiveness of two feedback modes, verbal definitions and numerical examples, in a CAI program on mathematical proofs. Ss were 9th graders, 15 of whom received a set of necessary definitions prior to the program, 15 who received correctional feedback in numerical form, and 15 who received definitions plus numerical corrective feedback. The groups who received the definitions and the numerical feedback took significantly less time (3 hours) than the third group (4 hours) and the mean post-test scores did not differ significantly among the three groups. However, in performance on the program itself the definitions group was superior to the numerical examples group. Studies by Jensen (1966) and Scandura (1967) on feedback in CAI are also cited.

Hall, Adams, and Tardibuono (1968) studied the effects of providing feedback in the form of the full correct response when an error was made or of pointing out matching letters of the alphabet between the correct answer and that given by the student. Undergraduate Ss learned states and capital cities. The group who received full response feedback took significantly less time to complete the program, but the amount learned did not differ significantly between groups.

Gilman (1968a, 1968b) studied the effects of five types of feedback in a multiple-choice response mode CAI program: (A) no feedback, (B) knowledge of results or merely saying "correct" or "wrong" to the student, (C) identification of the letter of the correct answer, (D) explanation of correct answer, and (E) B, C, and D combined. There were 15 Ss in each group who were instructed with a CAI program on general science concepts. Ss were stratified with a mental ability measure. Ss in groups D and E experienced significantly more certainty about the correctness of their responses prior to feedback than Ss in A and B, Ss in groups C, D, and E earned significantly higher posttest scores than Ss in A and B, but there were no differences among groups in attitude toward the methods of instruction.

Silberman, Coulson, Melaragno and Estavan (1960) studied the effects of branching and fixed-sequence instruction in a CAI program on logic. Thirty-six college students served as Ss. Branching students received a sequence determined by their errors. Fixed sequence Ss were paired by ability level with branching Ss and each number 2 member of the pair then received a program in the sequence order of his branching mate. The difference between groups on the criterion test of achievement was not significant.

Coulson, Estavan, Melaragno, and Silberman (1962) reported another study on the use of fixed sequence and branching using the same instructional material (but revised) on logic used in the previous experiment. Fifteen high school students served as Ss in each group. The groups did not differ in time to complete the program, but this time Ss in the branching program scored significantly higher on the criterion achievement test.

Wodtke, Brown, Sands, and Fredericks (1968) used undergraduate Ss and CAI programs on modern mathematics and speech pathology to investigate the effects of logical and scrambled frame sequences in CAI. The modern mathematics program was judged to be conceptually structured and therefore judged to require a logical frame order while the speech program consisted of discrete concepts which would not be as dependent on logical sequence (or scrambleable). There were no significant posttest differences between the logical-order and scrambled-sequence groups in either subject matter, but the logical-order group performed significantly better on the modern mathematics program (structured) than did the scrambled group in terms of errors and time on the program.

Gilman and Gargula (1967) studied the effects of linear and branching sequences in a physics program on dimensions analysis. The branching program included remedial frames which were used only when Ss made errors. Ss were adults who took slightly over an hour to run the program and who were divided into branching and linear treatments. There were no significant differences in posttest performance between groups, but branching Ss used significantly more frames.

Johnson and Borman (1967) evaluated three types of stimulus presentation in CAI: (A) typewritten, (B) audio, and (C) booklet. There were unequal Ns in groups and a total of 90 Ss in the three experimental and one control groups. The instruction consisted of about one hour of material on physics. All three experimental groups scored significantly higher on the posttest than controls, but there were no significant differences among the three experimental methods.

Individual Differences and CAI

Several of the studies already reviewed provided for some investigation of individual differences (IDs) in CAI. They will be cited again as will several other studies in the discussion which follows of IDs in CAI. Fundamentally the researcher may simply be interested in IDs per se, or he may be interested in the interaction of IDs with method. The latter is the principal concern of studies which are reviewed next.

Melaragno (1966) studied three methods of administering a CAI program in geometry to high school students. One group used a linear program, a second group was branched on the basis of pretests, and a third group was branched on the basis of performance in the program. There was no difference in achievement among the three groups, but the third group took significantly less time than the second, who in turn took significantly less time than the first, the linear group.

Davis, Denny, and Marzocco (1967) reviewed theory and empirical research on individual differences in learning and reported research on the interaction of individual difference and method variables in CAI and PI in a college-level remedial mathematics course. The IDs included numerous ability, attitude, and interest tests. They concluded that the ID variables had no relationship with the treatments and were of no value in prescribing instructional treatments.

Mitzel (1967) presented a final report on the development and evaluation of four college courses developed for CAI. Evaluations were run for high and low ability students. The courses included audiology, accounting, economics, and modern mathematics. Comparisons of CAI with control group achievement were made for only two of the courses, and these results revealed no significant differences. However, the high-aptitude group had signifiicantly higher posttest scores, fewer program errors, took less time on the programs, and developed more favorable attitudes toward CAI than low-aptitude subjects.

Brown and Bahn (1968) studied the effects of prior knowledge of the subject matter on learning from CAI programs on modern mathematics which did or did not make provision for preexisting individual differences. There were 32 and 33 Ss in the two treatments respectively. Ss' level of prior knowledge was measured. Ss with prior knowledge of the subject scored significantly higher on the post and retention test than those with no prior knowledge in the treatment which provided specific provision for these IDs. Ss who had prior knowledge took significantly less time in the program in the treatment which provided for IDs than in the treatment which did not.

Gilman and Gargula (1967), in the study on modes of feedback, found that low-ability Ss took more time to do the program than high-ability Ss.

Silberman et al. (1960) found that student aptitude was significantly and positively correlated with posttest scores in both linear and branching programs and negatively correlated with time to do the program and number of errors in both methods.

In the study by Coulson et al. (1962), in which significant differences were found favoring the branching group on the posttest, correlations between aptitude and posttest scores were not significant in either the linear or the branching group.

In the previously cited study by Wodtke et al. (1968), it was found that logical structure of subject matter in CAI is important if the subject matter has inherent structure and the S is low in ability.

O'Neil, Spielberger and Hansen (1968) used a CAI program on complex numbers and compound fractions which could be completed in one sitting with 26 undergraduate Ss who were given an anxiety-inducing message when they arrived. The program was divided into a hard and an easy part. They found that Ss responded to difficult CAI materials with an increase in self-report and physiologically measured anxiety (blood pressure) and that high-anxiety Ss made more errors in the difficult portion of the program than low-anxiety Ss while low-anxiety Ss made more errors on the easy part.

Wodtke, Mitzel and Brown (1965) reported that low achievers found instruction on a remote CAI terminal to be too rapid.

Stolurow and Davis (1965) reviewed studies of the interaction of ID variables with method of instruction and concluded that such interactions do, in fact, occur in a variety of instructional settings and methods. They also suggest that CAI will be a tremendous aid in conducting research on ID-method interactions and in implementing instruction which matches student with method.

Summary

The research reviewed in this report indicates that CAI has grown rapidly into a dynamic and promising field for educational research and for applied instruction. While the empirical research per se is often of poor quality and poorly reported, the development of systems and instructional theories is proceeding with great promise. This development of systems should pave the way to better research in the near future.

The empirical research reported so far of comparative studies, basic instructional variables, and of individual differences is probably quite inadequate because the CAI systems are so often being developed simultaneously and because terminal time is still often prohibitively costly. Thus, much or most of a research budget might be consumed by computer and telephone line costs. Nevertheless the evidence clearly indicates that CAI will teach at least as well as live teachers or other media, that there will be a saving in time to learn, that students will respond favorably to CAI, that the computer can be used to accomplish heretofore impossible versatility in branching and individualizing instruction, that true natural instructional dialogue is possible, and that the computer will virtually perform miracles in processing performance data.

What will be needed in CAI research will be systematic analysis of basic instructional variables and individual differences with Ss who have transcended CAI's newness and with hardware and software which is fully debugged. Efforts to taxonomize CAI instructional and individual differences (ID) variables can point the way to systematic research. The PI movement generated a program of research on major instructional and ID variables. The reviews by Holland (1965) and Klaus (1965) document well the comprehensiveness and logical consistency of this research, even though the results were sometimes equivocal (Feldhusen, 1963; Schramm, 1964). The CAI movement and its researchers should profit by careful attention to the PI research with a design both to emulate its strength and to avoid its weaknesses.

For the present we must conclude that CAI has accomplished the feasibility stage. Students can learn from CAI when taught didactically and inductively, the computer promises unusual instructional control powers not possible with any other media or with live instructors, and the potential for research on CAI and on basic learning process is extremely promising.

The transplant patient, the classroom, has a new viable heart, the computer, which will bring new levels of instructional vitality to the classroom and enable education to survive the challenges of the decades ahead.

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Computers In Education—The Full Spectrum

By Alfred M. Bork

NEARLY every journal concerned with education today includes articles extolling the computer as a teaching device. I am quite sympathetic toward this literature. As many aspects of education involve information handling and information transfer, and as the computer is an extremely effective device for storing and manipulating information, the computer will be usable in a wide variety of ways in education. Furthermore it has considerable intuitive value for many students. Whether the computer will be used in reasonable ways, and whether these uses will improve in any overall sense the educational system, still remains to be seen.

One specialized aspect of the computer-teaching literature often disturbs me, and that aspect is to be the focus of this paper. We have at the present time only partial insight as to *how* the computer can be effectively used in teaching. The range of possibilities, even those already tried, is enormous. Many of these possibilities are exciting. However, much of the literature concentrates on a very small segment of the total "market." This issue is complicated by questions of sheer terminology. The name Computer-Assisted Instruction, or CAI, has been commonly used to refer to the uses of computers in education. A number of other acronyms are in use, but CAI has become dominant. Yet those of us who would like to interpret CAI as meaning *any* use of computers in teaching are confronted more and more with the use of CAI to suggest only a very narrow range of computer-teaching possibilities.

I should hasten to say that I do not mean to imply anything wrong or intrinsically bad about the activities often now called CAI. Rather, my argument is that this use is not the whole story, but only one component.

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Most people who now write about CAI seem to be referring to the use of the computer as a branching Skinnerian teaching device. The typical CAI situation presents a computer-generated question, either typed or on a CRT screen, followed by a typed student response; this procedure is repeated many times to form a dialogue. The computer question chosen from a large store of questions can be related to previous student responses and other information about the student, such as his background, I.Q., and previous course material. Thus, ideally, a teaching conversation with a computer can be extremely individualized, drawing heavily on the previous training, abilities, and performance of each student. Visual and audio material, presented in several different ways, can also be part of the dialogue. A kind of complexity and individualization is possible that could be orders of magnitude greater than is obtainable either by programmed books, or by simple non-computer-based teaching machines. It is upon such conversational uses that many of the discussions of CAI focus, and so CAI has come to suggest just such a conversation to many people.

Many computer languages have been developed for the creation of such student machine dialogues. Perhaps the most widely-used of these languages has been the IBM-developed COURSEWRITER, initially available on 1410-7010 computers, but now, in a new version, available for the IBM 1500 and, in experimental version, for System 360. COURSEWRITER is termed an "author" language, making it possible for a teacher with little computer experience to describe a student-computer dialogue with minimum concern for the oddities of the computer. Many other languages of this same type (PLANET, MENTOR) exist, and this area continues to develop. A number of languages developed entirely for other purposes, including SNOBOL, APL, and PL/1, may also be considered possible to use.

An enthusiast for computer uses in teaching might well feel considerable danger in this emphasis on computer-student dialogues as the only form of CAI. Experience shows that effective dialogues are difficult to build in some areas. Numerous man-hours can go into their construction, and many people who have worked in the field feel that we are still at an early stage in understanding how to construct such dialogues.

Hence, the remainder of this paper emphasizes ways of using computers in teaching. When we examine the full spectrum of computer usage, we already see some startling successes, which were brought about relatively modestly rather than by massive inputs of people and machines. I would not want to claim to describe a complete catalog of computer usage in teaching. Nevertheless, I want to emphasize that there is a spectrum of ways, not just one, in which computers can be used in the teaching process.

Computer-Produced Materials

The first frequency in the computer education spectrum is in some ways the most usable in most classrooms, because no computer is needed on the premises. Here the computer produces standard kinds of teaching material for already available media.

Perhaps the most spectacular production use in recent years has been the upsurge of computer-generated films, particularly in physics and mathematics at the college level. In situations where the film requires some computation, and where the material to be displayed is largely in the form of line drawings or graphical information, the computer gives a valuable technique for making animated films. Often in modeling the world, computer-generated films have a ring of authenticity about them that is difficult to surpass with standard animation methods.

To make a computer film we begin with a computer program, usually in a commonly available language such as FORTRAN. The program describes the necessary calculations and also describes visually what each frame in the film is to look like. The procedure for visual description varies from language to language. The commonly available languages allow us to associate numerical values with points on the screen, and to draw lines between points. Letters can also be drawn on the screen. The FORTRAN program itself is likely to be entered in the computer as a deck of punched cards. The computer drives a cathode ray tube and a camera. The computer signals the electronic device to construct line after line on the surface of the cathode ray tube, and the film advances from one frame to the next, also on signal.

Computers can also produce other materials. Films are composed on individual frames in order that graphic material of the type that usually occurs in books, or in over-head transparencies, can be computer produced, at least partially. The computer can "draw" a 16 or 35mm negative of the material, working much as it does in film production, and then the negatives can be photographically enlarged to any form desired. Thus one could produce a library of functions, graphs showing many different cases.

Increasingly the computer is employed in book production, usually for hypheniization and typesetting at present. One can foresee, in a not too distant time, an author, assisted by an available computer-editing system, developing a book from its earliest stages. The writer, or his secretary, will type the earliest rough drafts at the computer terminal. These can then be modified by typing only changes and corrections, and can be examined both by the author and by the publisher. The copy at all stages is in computer storage, so it can be fed to a computer-based typesetting system for final production. While very few books are produced in this fashion at present, it seems likely that textbook materials will be more and more oriented toward computer production.

Simulation

A computer usage which shares some characteristics of CAI dialogues and other computer uses, is the simulation of laboratory experiences. An elaborate program of this kind was developed several years ago for a qualitative analysis laboratory. When the student indicates that he is ready, the computer "generates" an unknown compound. The student asks for various tests to be made; he receives the results either through the typewriter or through slides. The procedure for qualitative analysis is very structured, so the student is told immediately if he moves outside the structure. Thus he can have at least some of the experiences of conducting such a laboratory, without handling chemicals.

In simulations the computer models something. The information determining the modeling may be the detailed consideration of what happens, as in the qualitative analysis example, or it may be the basic laws involved. Thus in a physics laboratory the student can study arbitrary forces, with initial conditions of any kind, in examining particle motion. Here the "ingredients" are the Newtonian or relativistic laws of motion. Relatively few forces can be created in an actual laboratory, so the modeling allows the student much more experience with experimental dynamics than he could obtain through the usual laboratory procedures. The student need not work actively at computer terminals, although he certainly could gain some experience there. For example, computer-produced films on motion can aid in at least part of such study.

We should not insist that these simulated laboratories replace actual laboratories. But, on the other hand, the situation is intellectually honest, particularly in those instances where the computer does not have all the answers, but works from the same laws that presumably would be applicable in the laboratory itself. Game-playing, particularly in economic situations, is another example of such "honest" modeling.

The possibility of creating imaginary worlds, with different laws from our own world, is also intriguing. Here we can let the student have experiences impossible in any other way. This exploitation of non-existing worlds, creating new environments, may prove to be a useful pedagogical device.

Computer-Directed Teaching

Another aspect of computer usage in education, already used in several places, depends on the establishment of a large data base in computer memory. Such a collection of data can be structured and used for educational purposes. The goal is to provide guidance, either to the student or the teacher, to assist the learning process. The information provided will be dependent on the data base, the stored information about students and curriculum material. It can include student performance information, such as scores on previous tests and information about what has been studied.

Guidance is one variant of computer-supplied direction and information for students, particularly with regard to career or college choices. Experience shows that much of the information students want is routine, information available in printed form. The computer can store large amounts of such information, and so can answer many of the questions a student might have. More difficult questions can be referred to a counselor, so the counselor could function more effectively than he does in the present situation.

Another usage sometimes called computer-assisted scheduling is already available. The aim is to give the student direct guidance within a particular course. In one program, in the teaching of elementary reading, the student takes a machine-gradeable test at regular intervals during his early reading experiences. Based on these tests, various remedial materials are suggested to the teacher, many of them materials written to match the needs shown by the tests. Thus the teacher can keep a close record of the student's weaknesses and has an effective way of dealing with them.

More generally, the computer can be used to match students with curriculum materials. The science teacher who wants to give students material about a particular topic can inquire at a computer terminal. Using data about the students, what they have already used, how they have performed, and which things are currently available, a computer program can be developed to match requirements with availability. Or this can be done directly by the student, particularly at higher levels of education.

Another variant on a computer education information base would be as assistant to the teacher, offering him background information and assistance beyond that needed for course materials. Here the computer would take over some of the functions of the typical teacher guide or teacher handbook often available for courses.

In all of the above situations it should be clear that the computer's effectiveness depends entirely on the skill with which the data is accumulated, and on the development of specialized languages to facilitate the teacher's or student's use of the data. Major developmental projects are needed to implement these programs, projects which demand a range of expertise on the part of the developers.

Computers as Computers

In discussions of the use of the computer in teaching, ironically, its use directly as a computer, as a computational device, is most ignored. Perhaps this is because no spectacular new computer developments are needed. We can work with existing languages, such as FORTRAN, and immediately obtain some teaching power.

Although any computer, with almost any general-purpose programming language, can be used for these applications, nevertheless student accessibility is affected by the computer facilities and languages available. With regard to facilities, the most difficult to work with is the typical large university batch processing facility, with program turn-around on the order of one day. The interval between the time you put the program in and the time one gets back response is too large for convenient student use. Better facilities of three different types, each with some special desirability features, exist.

First, there are the "fast batch systems," where the programs are still run in sequential mode in an inaccessible computer center, but where the turn-around time is on the order of minutes rather than hours. The student may go to the central computer facility or may use a remote job entry facility, perhaps at some large distance from the computer center.

A second possibility which improves the computational uses of the computer in educational environments is a smalll standalone computer the student can run himself. Modern small computers are easy to operate, so a student can quickly learn the details. He gets a fast response, because he is there as it happens. Furthermore, he gets a "hands-on" feeling often missing in other methods. Small computers are now available for under $10,000. In a large university individual departments can have small computers primarily for student use.

The third possibility, time-sharing, has gotten the greatest publicity. In time-shared systems many people, each working at individual terminals, use the computer. Each views the computer as his own. The computer does the bookkeeping of switches between each user, making certain that no one has to wait very long before getting response. Particularly with the relatively small student problems likely to arise at first in computational uses, time-sharing can be very effective. The immediate line-by-line response allows the corrections and modifications in a more convenient manner than with other systems. On the other hand, time-sharing systems with large numbers of terminals are still relatively expensive. Sometimes too the desirable conversational features are not present.

With all the systems discussed, but particularly with time-sharing, the availability of new languages is important. A few years ago a number of algebraic-like languages, related to FORTRAN but more convenient in many ways, were developed particularly for time-sharing facilities. The most prominent of these were BASIC and JOSS (JOSS now has a family of related languages: CAL, ISIS, BRUIN, PIL, TELCOMP). More recently a number of languages have been developed which have greater internal power, and which are also amenable to time-sharing. These include APL and PL/1.

The teacher needs some guidance as to

what computational uses within the area are important. No general advice can be given because areas differ widely. The hope is *not* simply to use the computer to enable students to work more difficult numerical problems than those that he already solves. Thus the analogy between the computer and a glorified sliderule is misleading. Rather, what is wanted is rethinking of the course materials and restructuring in ways to take advantage of a computational facility as an adjunct to teaching the course. Thus the curriculum should change, perhaps drastically, but in ways that will be designed specifically for the area.

Hence, a reasonable computational computer use will not lead to teaching the same material with the same approach used before, but to redesigning a whole course, or even a whole curriculum.

As an example I consider physics, the area most familiar to me. Here one of the major advantages of the computer is to allow the student to use differential equations quickly, even at a relatively elementary level. Previously in physics courses, differential equations have been reserved for intermediate level treatments; they have been little used at the high school and beginning college level. Yet much of both classical and contemporary physics is based on investigating the properties of the solutions of differential equations. Hence any procedures which bypass usual elementary treatments and move much more quickly to differential equations will contribute powerfully to the teaching of physics.

In the beginning physics course, in classical mechanics, the usual algebraic approach can be avoided by proceeding, with the assistance of the computer, to differential equations. The computer makes this possible because the numerical approach with the computer to the solution of differential equations is accessible at the beginning level, in contrast to the usual analytic approach which has led to avoidance of differential equations in the beginning course. Thus one has a different approach to interesting physics which allows a new path into beginning physics.

We should be careful not to exaggerate. I would not want to claim that all areas of all courses have such dramatic possibilities. Even in physics many areas at present seem to show little advantage from computer computational uses in the sense just discussed. But experience may show more. Again, as with other aspects of this discussion, we must remember how little detailed information is currently on hand.

Conclusions

No doubt others can point to examples in the computer education spectrum which I have omitted but I am certain of one thing: The future of computers in education will be an exciting adventure.

GPERSEVERANCEIUS

Caught your eye, didn't it? And well it should, for there is a combination of two words that have meant more to the world throughout the centuries than anyone can measure. But it is perfectly clear when we quote this couplet from Henry Willard Austin: "**Genius,** that power which dazzles mortal eyes, is often but **perseverance** in disguise."

—Sunshine Magazine

Some Applications of Natural Language Computing To Computer-Assisted Instruction

By

Dieter H. Paulus, John McManus, and Ellis B. Page

COMPUTER-ASSISTED instruction systems may be classified in many different ways. It is probably easiest to think of three levels of CAI. The first, "drill and practice systems," is the lowest level, in which the computer does not modify its presentation as a result of student response. This level is analogous to a simple, linear programmed text book.

The second level of CAI systems is "tutorial systems." Here, the computer examines student responses, and accordingly modifies its presentation of further material. The program may branch to various points, ask further questions, and give remedial work. This level is roughly analogous, in book terms, to a scrambled text.

The third level of CAI may be called "interactive" and may be illustrated by Weizenbaum's ELIZA. The goal is to provide the student with the richest possible interaction with a computer. He may respond in natural-language sentences and the computer may perform considerable textual analysis before proceeding. Such systems are generally experimental, and their programs require considerable sophistication. They are therefore associated with "artificial intelligence," and at this time are not easily adapted by the user concerned with CAI.

A serious difficulty with the first two levels of CAI, the linear and the branching, is that the computer must compare each student's responses with a precoded list of responses in order to evaluate them. The computer can assess a response only if it matches one of a list. This limitation produces at least two difficulties: first, the relative **length** of each response is limited, and second, the **number** of possible responses is limited. Granted, the system itself can retain a large number of alternatives, but the programmer's perseverance and imagination are invariably limited. For example, it may be reasonable, to code five alternative responses to an item, but not 500. Also, as the length of the possible response is increased, the number of different ways of expressing the response increases geometrically. But if a student responds in a manner not anticipated, the computer must either cue, ask for a clarification, or judge the answer to be incorrect.

To avoid these difficulties, the author usually limits the correct responses to single words or numerical values by posing only very specific questions, a strategy which may be expedient from the "systems" point of view, but is questionable pedagogically.

Some recent results from the University of Connecticut suggest that there may well be a solution to this dilemma. It has been demonstrated that a computer can be programmed to assess the relevant **content** of responses to some short answer test item, and to return a numerical grade which represents a judgment about its factual content. Before describing these strategies and results, however, let us review the general philosophy and strategies employed by the researchers associated with the project.

The initial goal of PEG[1] was to develop

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[1] Paulus, Dieiter. Feedback in Project Essay Grade. (Paper at the Annual Meeting of the American Psychological Association, Washington, D.C., September, 1967.)

strategies for the computer grading of student essays on a number of stylistic traits. The first step in this general simulation problem was to hypothesize variables believed to be correlates of those other variables which might be actually used by human judges in the evaluation of an essay. Note, it was not assumed that these were the **actual** variables which human raters use in evaluating stylistic elements of an essay; rather these variables, called "proxes," are thought to **approximate** them in some way. Examples of these proxes, and there were 30 the first runs, a : standard deviation of word length, total length of the essay, and average sentence length. Once these variables had been hypothesized, a computer program[2] was developed which takes for its input key-punched student essays and returns a score on each of the 30 proxes for each essay.

Meanwhile a sample of 256 student essays was obtained. These essays were typed **literatim** and then rated by expert raters on each of the stylistic traits. In order to obtain ratings which were relatively reliable, each essay was independently evaluated by eight raters. Overall ratings on each of the stylistic traits were obtained by averaging the eight independent ratings for each essay.

The next step in this general rating simulation process was to take the scores which had previously been obtained by the computer for each essay and to weight these so that their sum would best predict the ratings which were assigned to the essays by the human raters. Accordingly, a number of multiple regression equations were calculated, each predicting one of the stylistic traits.

The correlational results obtained in this manner were most encouraging. It was found that the ratings assigned by the computer were virtually indistinguishable from those assigned by the expert human judges. The major implication for computer-assisted instruction of this finding is that an electro-mechanical decision procedure had been developed which, given essays of differential stylistic quality as input, allows for the branching to different points in a larger program. And the input was not a one or two word response or a number, but rather an entire essay written in the student's own natural language.

These results led to the next question: what else can a computer be programmed to say about a student's essay? To provide an initial answer to this question an experimental computer program was developed which allows a student to type an entire essay on a remote computer console. After the student has completed the essay, the computer responds almost immediately by typing a series of prescriptive and evaluatory comments.

These comments are based on four characteristics of the essay. First, the computer calculates a grade for the essay, in the previously described manner, and reports this grade to the student along with some general comments about the meaning of the grade. Next, the computer compares each word in the student's essay with a list of common misuses such as taboo words, idiomatic expressions, noun-verb disagreement, and so on. If the computer discovers such a misuse, then it is programmed to type a comment on the console. For example, if the computer encounters the word "somewheres" in the student's essay, it types: " 'Somewheres' is an example of poor speech habits showing in your writing. The word should be pronounced and spelled without the final 'S'." Third, the computer types comments which are based on certain actuarial characteristics of the essay. If, for example, the essay is very short, then the computer responds: "Your essay is considerably shorter than the assignment required. Have you fully developed the topic?" Finally, the computer calls any spelling errors which it has found to the student's attention. The student is then asked to correct these errors, and the computer informs the student when he has done so.

Thus, we have an experimental interactive system which takes for its input an entire student essay and then branches to

[2]This program, written primarily in FORTRAN IV, was developed for us by Mr. and Mrs. Gerald Fisher of the University of Connecticut.

different points in the program as different difficulties in the student's writing are discovered by the computer. Note that instead of typing any given prescriptive comment, the computer can just as easily refer the student to explanatory materials or present the student with several test questions.

From the computer-assisted instruction point of view, however, both of these programs have several shortcomings. First, both of the methods require sophisticated programming in languages which are generally not feasible for the CAI programmer. Second, both methods focus on the stylistic elements of the student's writing. There are, at present, no features in these systems which allow for the evaluation of the factual content within any one response. And it is this factual content which is currently of greatest interest to the computer-assisted instruction programmer.

A newly emerging strategy that has been developed at Connecticut, and is reported in detail in a recently completed doctoral dissertation by John F. McManus,[3] overcomes both of these difficulties. It provides for the scoring of an unstructured response for its factual content, and the application of this strategy to a computer-assisted instruction setting requires only trivial programming.

The type of student response to which this strategy was applied is that generally associated with "identification" items. Specifically, the instructions to the students were:

> "Briefly identify and very briefly show the historical significance of the following:"

This was followed by a list of twelve terms and concepts taken from the general content studied in a "History of Western Civilization" course. The students, about 90 of them, who responded to these items were college freshmen and sophomores at the University of Connecticut.

In order to obtain criterion ratings which the computer was to estimate, the factual content of each response was rated by eight highly qualified human judges. These judges were graduate students in history at the university. Once the responses for each item had been rated, they were randomly divided into two samples. The first sample, consisting of approximately two-thirds of the responses, was used to develop the initial computer strategies. The remaining one-third of the responses were used as a cross-validation sample to evaluate the strategies once they had been developed.

The first step in the computer evaluation of these data was an effort to determine in what measurable ways the responses of those students who seemed to know the correct answer differed from the responses of those students who did not appear to know the correct answer. Specifically, we wanted to isolate those key content-loaded words that seemed to characterize the good response.

To do this, the responses to each question were further separated, into two subsamples. The first sub-sample consisted of the best 27 percent of the responses: the second part contained those responses which fell in the lower 27 percent, according to the grades assigned to them. A program was then developed which instructed the computer to construct an alphabetical list of all the words which appeared in each of these two groups, along with a count of the number of times each word occurred. The two word lists were then compared by the computer and the computer reported first all of those words that were used by both groups of students, as well as their frequencies. Next, the computer prepared a list of words employed only by the high group, along with the frequencies of occurrence of each word. Finally, the computer prepared a similar list for the low group.

These lists were then examined and those content-loaded key words which best differentiated between the high and the low groups were selected. Another way of looking at this procedure is to consider each word in either of the two groups of responses as a test item, and to think of

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[3]McManus, John. Computer Evaluation of College History Examinations by Actuarial Strategies. (Unpublished doctoral dissertation. University of Connecticut, Storrs, Conn. 1968.)

the difference indices which were obtained as being analogous to standard item discrimination indices.

Thus, this method provides for selecting those key words which characterize the responses of those students who knew the correct answer as compared to those that did not know the correct answer. As will be seen later, the frequency occurrences of these words will correlate with the score or grade which a student received on his response. The words can, therefore, be employed in predicting the grades.

Another characteristic of the responses which was found to be highly useful in predicting ratings was the total number of words which the student used in responding. That is to say, it was found that the student who received a high grade on a given item tended to use a greater number of words in his answer than the student who received a low grade. There is, however, a danger in utilizing a variable of this type in the predictive context. In any interactive situation, the student would probably quickly learn that the computer will look favorably upon a long response. Even though the student may not be intentionally trying to "fool" the computer, he would soon be conditioned to provide longer responses.

To overcome this difficulty a differential weighting procedure was employed for this length variable. That is to say, it was desired that length receive a large weight in a predictive equation only if the response was relevant to the question at hand. However, if the student simply provides a long answer which is not relevant to the question, then length was to be weighted less heavily in the predictive equation. The general concept of configural test construction, employing moderator variables, seemed ideally suited to this problem. In general, this approach allows for the weight which a variable receives not to be a function of only this variable's correlation with a criterion and with other variables, but for the weight to vary as a function of the student's score on some other variable.

This technique was employed and a new variable termed "relevancy" was created. A subject's score on this variable was partially determined by the total number of key content words that appeared in a given response. Each student's score on this relevancy variable was then simply multiplied by the total length of the subject's response. It can be seen, then, that if a subject used many words in his or her response, but used few or no **relevant** words, then the length was multiplied by a very small number. The resultant value would, of course, also be small. On the other hand, if a subject gave a response of moderate length, and used many relevant terms, then two moderate size numbers would be multiplied, yielding a large score for the subject on that variable. The relevancy score may, therefore, be said to be an inter-action between the subject's length score and total key content word score. Thus, this measure depends to some extent on length but not entirely so. The student can, therefore, no longer effectively "fool" the computer.

The first step in implementing this strategy was to select the key content words as previously described. It was found that for each item there were approximately seven content words which differentiated well between the low and the high groups. The next step was to determine the occurrences of these terms in each of the responses. To do so, the SCORTXT[4] system was employed. This system, a generalized word and phrase-look-up procedure similar to the General Inquirer,[5] took for its input the individual responses and dictionaries made up of lists of the key content words in which we were interested for a particular item. The output consisted of the identifying information for each response, a count of how many times each key content word appeared in each response, and the total number of words in each response. The scores thus obtained were then used, along with the appropriate transform for the interaction, to predict the grade of each response. To do so

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[4]Fisher, Gerald. The Scortxt Program for the Analysis of Natural Language. Mimeo. University of Connecticut, Storrs, Conn. 1968.

[5]Stone, Phillip J., Dunphey, Dexter C., Smith, Marshall S., and Ogilvie, Daniel M. **The General Inquirer: A Com-Approach to Content Analysis.** Cambridge: M.I.T. Press, 1966.

the variables were entered in multiple regression equations predicting the grades assigned to given items.

Let us now turn to some of the results which were obtained in applying these strategies. The initial multiple correlations which were obtained give some indication of the relative success of the approach. It is well known, however, that given a relatively limited sample, the approach undoubtedly capitalized on sampling error unique to the particular cases which were selected. To get a more general estimate of the validity of the equations, the obtained weights were applied to the remaining one-third of the sample of original responses which we collected. Thus, an empirical estimate of the cross validity of the multiple regression equations was obtained.

The estimates of the validity of our equations were found to range from .53 to .79, with seven of the eight validities exceeding .60. At a first inspection, it may seem that these validities are not exceedingly high; a large proportion of the variance remains unexplained. However, in meaningfully evaluating such validity indices we must always have a basis for comparison. Obviously, in this case, we want to be able to compare the validity of obtaining grades by this method to the validity of the human rating. And some estimate of the validity of the human ratings may be obtained by examining their reliabilities.

As previously indicated, each response was independently evaluated by eight independent judges. An examination of these judgments revealed that the average intercorrelations among these judges ranged from .35 to .49. In estimating the pooled reliability of the judgments, via analysis of variance, it was found that the average correlation between an **average** rating of eight judges with another average rating of another eight judges would range from .78 to .84. Examining the above results in this perspective, it can be seen that the computer did somewhat better than the average single judge, but not quite as well as the pooled ratings obtained from a group of eight judges. That is to say that the effectiveness of the method falls somewhere in between these two extremes.

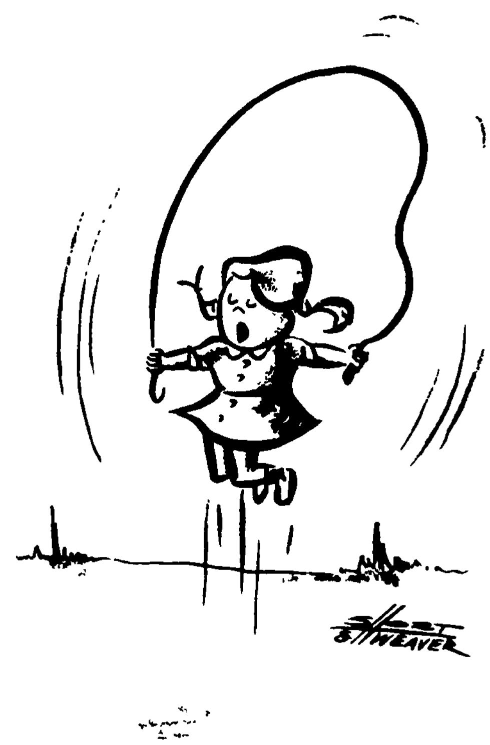
A limiting factor in these analyses was the fact that the interaction variable did not really have a chance to work as well as it can. This was due to the fact that there were no totally irrelevant responses given by any of the subjects in the sample. That is to say, no answer received an average grade of zero. To evaluate the potential effectiveness of this interaction variable a further analysis was conducted, using the previously described techniques, and including a number (about 50 percent) of clearly irrelevant responses. This time, the cross-validated validity coefficient which was obtained was .82, a value which closely approaches the reliability of the **pooled** human rating; the upper limit of predictability.

Let us examine what relevance these findings have for the computer-assisted instruction programmer. First, it seems obvious that the CAI programmer can not include all of the necessary computer code to develop for himself the necessary multiple regression equations which we have described. This would make the development of any system which makes use of these strategies prohibitively difficult and tedious and would call for a tremendous duplication of effort. What the CAI programmer **can** implement, however, are the multiple regression equations which have already been developed. In order to develop the appropriate equations for use on a CAI system, the programmer can collect the needed data on an appropriate topic, utilizing the existing programs which perform the necessary calculations, sorts, concordances, etc. Then the resulting equations can be adopted for CAI use.

To illustrate this process a rather simple program was developed. Here is how it operates. First, the computer prints some explanatory material for the student on the general topic of "Canon Law." Then the computer asks the student, in an effort to determine how much the student has learned, briefly to identify and to show the historical importance of that concept. The student is asked to type the response on the console. A brief and simple FORTRAN program then instructs the computer to examine the student's response, and to do the following: first, count how many of the previously derived key content words appear in the student's response. Second, count how many words the student has used: that is, how many non-blank characters are followed by blanks. Then the computer is instructed to combine these various counts, multiply them by previously derived constants, and sum them so as to arrive at a grade.

Once this grade has been determined by the computer, it branches to various points in the program depending on what the estimate of the grade was. For example, if the grade was equivalent to a "D" or less, the computer supplies further information on the concept to the student. If the grade is a "B" or better, the computer moves on to new material. And if the grade falls somewhere in between, then the computer initiates some different action.

In summary, we know that one thing that limits the pedagogical effectiveness of many of the current computer-assisted instruction programs is that the student's responses are limited, both in length and in alternative responses. This, in turn, limits the flexibility of the CAI programmer because he is limited in the types of questions which he can ask the student to answer. To partially overcome this problem, a computer algorithm was developed which takes for its input an answer which is several sentences long, and returns a grade which a group of expert human raters would assign to that response. The algorithm does this by first selecting key content words which are used by the student, and then by considering an appropriately weighted composite of these key content words as well as the length of the response. Although the algorithm has, at present, only been tried with one type of test item, there is little reason to believe that the method may not be generalized to a wide variety of responses. By employing these techniques, then, the computer-assisted instruction programmer is given a great deal of flexibility in the type of questions he may ask of the student, and the type of responses the student may supply. The computer may almost be said to "understand" what the student has said, and then may take appropriate action on the basis of this "understanding."



"COMPUTERIZED... ANALYZED... HOMOGENIZED... SYSTEMIZED... STANARDIZED...."

Expressed Student Attitudes Under Several Conditions Of Automated Programmed Instruction

By Bobby R. Brown and David A. Gilman

THE MAJOR focus in computer-assisted instruction today is on achieving the highest possible criterion performance in the shortest possible time for all students. To raise the question of student attitude toward computer-assisted instruction (CAI) or toward the instructional material presented via CAI may seem to many to be an irrelevant diversion from the major problems that challenge researchers in this area. Some attention has been given to the effect student attitude has on various performance measures (Eigen and Feldhusen, 1964; Wodtke, Mitzel, and Brown, 1966; Wodtke, 1965; Campbell and Chapman, 1965). These studies have been, for the most part, correlational investigations of the relationship between student attitude and such criteria as error rate in the program, time required to complete the program, or achievement score. In investigations of this sort the focus is still on "the highest possible criterion performance in the shortest possible time," and student attitude is seen as a relevant factor only insofar as it facilitates or interferes with the attainment of this goal.

On the basis of the above referenced studies, the following tentative generalizations seem to be justified:

1. Correlations between student attitude and performance measures tend to be positive but generally small, accounting for less than twenty percent of the variance.
2. Due to the correlational approach taken in these previous studies, little can be said about casual relationships between student attitude and performance.
3. It seems likely that student attitude is at least partially a function of the specific characteristics of the student-subject matter interface. If this is the case, various research findings may be to some extent system specific.

These generalizations seem to indicate that student attitude may not be a very important variable in short-range studies. However, when one considers long-range, routine use of CAI, student attitude may become considerably more important.

It is almost a truism in education that one outcome of a course or unit of instruction should be heightened student interest in continuing to learn more about the material being taught. In this context student attitude becomes important as one factor influencing "post-criterion" behavior. Also, in teaching minimally motivated students by CAI the long-range effects of student attitude may be of considerable importance.

Due to the rather general finding that student attitude and performance measures tend to be only moderately correlated, it cannot be assumed that a program which results in satisfactory criterion performance will necessarily result in a positive student attitude. If it is granted that student attitude may have significant effects on students' behavior after the period of instruction, it seems that a different approach to the study of student attitude is called for. Rather than studying the effect of student attitude on criterion performance, research should be directed

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This paper was prepared while both authors were at the Computer-Assisted Instruction Laboratory, The Pennsylvania State University.

to developing instructional programs which achieve both satisfactory criterion performance and positive student attitude. In the remainder of this article an experiment is reported in which student attitude (along with criterion performance, see Gilman, 1967) was treated as one of the outcomes of instruction.

Method

Subjects. The subjects were 66 ninth and tenth grade students in the college preparatory curriculum of State College Junior High School. All were naive with respect to educational experimentation procedures, and none had received instruction in physics. All Ss who began the experiment completed it.

Materials. Three programmed courses were prepared. The subject of the three programs was dimensional analysis, or performing calculations involving units of measurement in working physics problems. The material of all three programs was identical with the following exceptions. The first program (CPF) was a CAI program utilizing Contingent Prompting and Feedback. The second (KCR) was also a CAI program, but feedback consisted of the Knowledge of the Correct Response. The computer typed the correct response two inches to the right of the student's response as in a typical programmed text. The third group (text) received instruction which contained feedback material identical to the KCR program, but was presented by a programmed text rather than by a computer-controlled terminal.

Equipment. CAI equipment used by the CPF and KCR groups consisted of IBM 1050 terminals connected to an IBM 7010 computer. Instruction was teleprocessed a distance of 250 miles between the terminals, located at University Park, Pennsylvania, and the computer, located at Yorktown Heights, New York.

Design. Subjects were randomly assigned to three groups. The randomization was accomplished by the use of a shuffled stack of student data cards. Ss were pretested with the ten question pretest. No S answered more than three questions on the pretest correctly and most answered all questions incorrectly.

In all three groups the instruction was completed in a single session. All instruction was "stand alone" instruction in that no other instruction was provided other than the programmed course. There were no difficulties with any of the equipment used during the experiment and the CAI groups experienced no down time or delays on the hardware.

Test

Student attitude was measured by a 40-item Likert-type scale, previously developed at The Pennsylvania State University CAI Laboratory (Brown, 1966).

Student responses were scored 1 to 5, with 5 being the response which indicated the most favorable attitude toward the instruction. The maximum attainable score was 200. Kuder-Richardson formula-20 reliability obtained during an earlier study (Brown, 1966) was 0.885.

The attitude scale was administered to each S following the session of instruction.

Results

The responses of each student to the 40 items on the attitude scale were summed to yield one score for each student. The data were analyzed within a two-factor, treatments by sex, analysis of variance design. The only significant difference found was between the three-treatment means ($F=12.89$, df - 2/62, $P < .001$). Scheffé's "S-test" (Sparks, 1963) was performed on the three-group means. This analysis showed that both KCR and CPF means were significantly different ($P < .01$) from the text group. The KCR and CPF were not significantly different from each other ($P > .05$). The results of these analyses are presented in Table 1. Previously reported performance data (Gilman, 1967) are presented in Tables 2 and 3 for the purpose of interpretation of attitude scores in relation to performance.

Discussion

Groups KCR and CPF scored significantly higher on the attitude inventory than did the text group. There were no significant differences between the KCR group and the CPF group. There were no differences attributable to sex.

Table 1

Treatment Group Attitude Score Means, Standard Errors, F Value, and Results of Scheffé's "S-test"

Group	$\overline{X}$	Standard Error	F	Scheffé's "S-test" Significances of Differences Between Pairs of Group Means at .05	at .01
KCR	151.73	3.80	12.89	text	text
CPF	146.82	3.80		text	text
TEXT	125.61	3.90		KCR, CPF	KCR, CPF

Table 2

Comparison of Means and Standard Deviations of Posttest, Retention Test, for On-line and Off-line Instruction in Dimensional Analysis

		10-Item Pretest	40-Item Posttest	40-Item 6-Week Retention Test
(A) Linear Programmed Text				
(off-line)	mean =	1.2	20.6	17.0
(text n=22)	Sigma=	1.1	6.6	6.3
(B) Linear Programmed Text				
(on-line)	mean =	1.1	20.0	15.3
(KCR n=22)	Sigma=	1.3	8.3	7.2
(C) Linear Coursewriter Program				
(on-line)	mean =	0.9	21.9	17.9
(CPF n=22)	Sigma=	1.3	5.8	6.4
(D) F Ratio		<	1.00	1.1
(E) Significance		n.s.	n.s.	n.s.

Table 3

Comparison of Mean Instructional Time for On-line and Off-line Instruction in Dimensional Analysis

	CPF		KCR	Text
Instructional Time (minutes)	68		52	42
F Ratio		16.17	($P <$	.001)

The differences between groups receiving computer-assisted instruction and instruction by programmed text are similar to the anticipated results. As can be seen from Table 2, the differences in attitude scores cannot be attributed to differences in performance as the three groups did not differ significantly on either posttest or retention test performance. The groups did differ on the amount of instructional time required (see Table 3); however, in this experiment there seems to be no basis for explaining attitude in terms of time per se. Apparently the more positive expressed attitude toward computer-assisted instruction as compared to the attitude expressed toward programmed texts is attributable to student preference for a novel automated instructional medium.

In the opinion of the authors the approach to the study of student attitude suggested in this report and illustrated by the above experiment should be employed, in conjunction with, if not instead of, the typical correlational approach, in research aimed at the development of instructional programs which achieve both satisfactory criterion performance and positive student attitude.

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CAI In Eastern Kentucky

By Morris Norfleet and Leonard Burkett

IN PAST years, much emphasis has been placed upon drill in arithmetic. Too many teachers have used rote drill on the basic facts and operations as the complete package of arithmetic instruction.

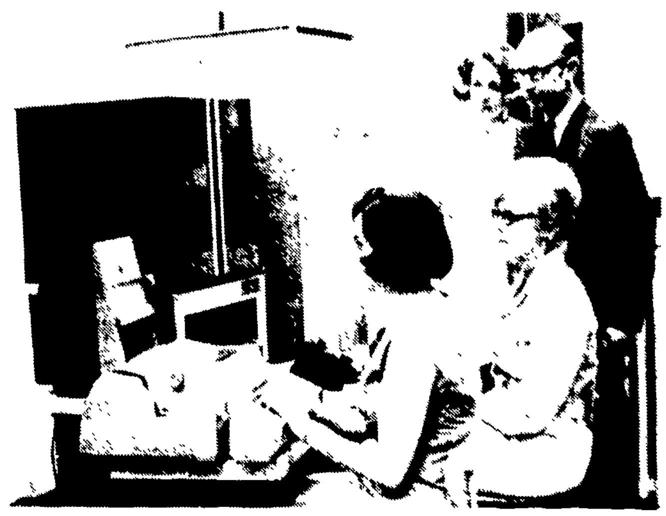
This emphasis on drill came under attack in the 1920's and 1930's and the pendulum swung to the other extreme of almost eliminating drill and practice. As a result, deficiencies began to appear in the mastery of the basic facts.

Meaningful drill and practice along with the development of arithmetic concepts seems to be the modern approach to teaching arithmetic. After the teacher works with the students in activities and illustrations on the concepts, drill and practice is furnished to firmly establish the use of facts and processes.

Drill and Practice Via Computer

Many times, teachers are hard pressed to find the time to adequately develop concepts, furnish the meaningful drill suited to individual needs, and check the results to diagnose weaknesses in the concepts. The task of drill and practice lends itself well to computer-assisted instruction. The computer can present exercises suited to the ability of the learner, check responses, and diagnose weaknesses with amazing rapidity.

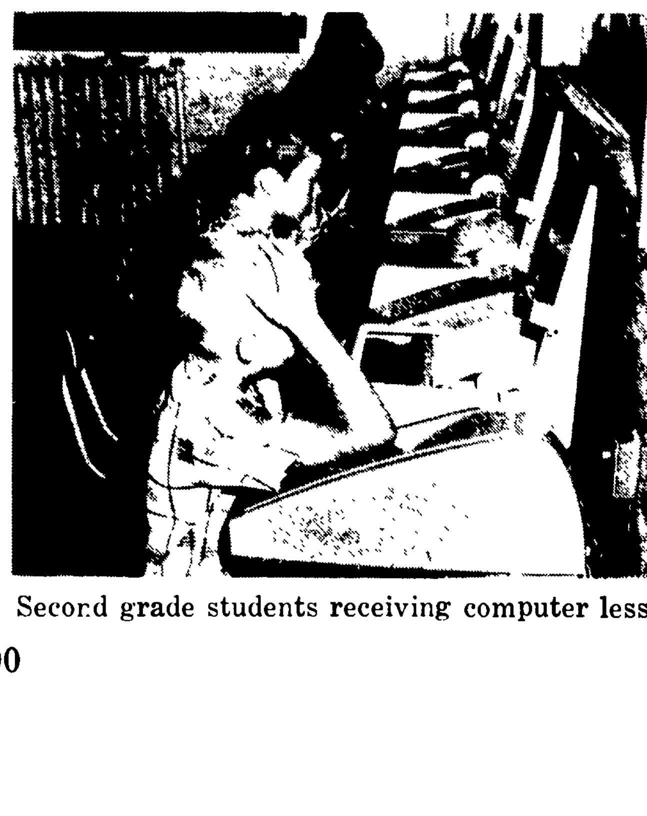
Such a program in arithmetic has been in effect in the eastern Kentucky area for well over a year. This program comes to the area via long distance telephone line from Stanford University's Institute for Mathematical Studies in the Social Sciences at Palo Alto, California. At Morehead State University, a PDP-8 Computer branches the program out to ten different schools in seven counties in eastern Kentucky. The program is now administered by Eastern Kentucky Educational Development Corporation, the applicant agency for Title III, ESEA, in Kentucky's Region VII. Coordination of the program is subcontracted to Morehead State University.



CAI staff at work

How the Program Operates

The lessons are presented to the student by means of a teletype terminal. The student activates the terminal by typing a pre-assigned number and his first name. The computer then takes over by typing his last name and presents his lesson.



Second grade students receiving computer lessons

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The lessons are arranged sequentially in concept blocks, following as much as possible the development of concepts as introduced in the more popular texts. A teacher is free to rearrange the order of concept blocks if the sequence does not coincide with her manner of presentation. Blocks from other grade levels may be inserted if needed for rapid or slow learners.

Each concept block consists of seven lessons. The first lesson is a pretest composed of problems of different levels of difficulty on the concept. Based on the percent correct on this pretest, the computer automatically selects for each student one of five lessons, each of a different degree of difficulty, for the next day's lesson. This lesson begins a series of five drill and practice lessons on the concept in which the performance on each determines if the next lesson is of greater difficulty, or of less difficulty. The seventh lesson on the concept is a posttest composed of problems of the same level of difficulty as the pretest. Comparison of pretest and posttest scores gives some indication of the benefit derived from working the five drill and practice lessons.

An added feature of the program is a series of review lessons "tacked on" to the regular lessons. These lessons, consisting of from six to eight problems, are chosen automatically by the computer for each individual and are selected from one of the previously completed concept blocks in which the student has the lowest posttest score. When his competency on this concept is built up to the point where this is no longer his weakest concept, his review lessons are chosen from his former next weakest concept. In this manner, each student is continually being reviewed in areas of individual weaknesses.

Each day, a printout of individual and class performance is given. This furnishes the teacher information with which to analyze strengths and weaknesses. This diagnostic approach to arithmetic teaching is one of the major benefits derived from the program.

Teacher Training

Teachers who are to utilize the CAI program in their classes receive special training through workshop participation. During the workshop, each teacher prepares teaching objectives from a behavioral change standpoint for a year's classwork in her particular grade, prepares end-of-year and grading period tests, and plans her year's work in arithmetic. Through observation and participation, the teachers learn how to operate the teletype terminals and how to make minor repairs and adjustments.

Dr. Morris Norfleet and Dr. Howard Russell, Central Midwestern Regional Educational Laboratory, explain a computer lesson to CAI workshop participants from Mississippi.

The workshops are conducted by the CAI staff at Morehead State University and consultants from California under a sub-contract to the Eastern Kentucky Educational Development Corporation. In the past year, four such workshops have been conducted for various groups of teachers and they may receive one hour of graduate credit for work done during these sessions.

The computer-assisted instruction program is closely coordinated with the University undergraduate and graduate programs. Therefore, it becomes a laboratory situation for teacher preparation on all levels to acquaint the prospective teachers with this approach to teaching. The coordinator of the CAI program also teaches the methods courses in teaching of arithmetic to future elementary teachers. The university students have practice sessions on the terminals, identify concept blocks and state their objectives for the blocks. In addition, groups of student teachers, psychology and special education classes are given orientation sessions, also observe students working on the computer and assist in activities in the computer laboratory.

A complete scheme has been developed for dissemination of information and results of the computer-assisted instruction program within twenty counties of eastern Kentucky. A planned visitation is scheduled so that all schools may visit one of the ten operational centers to observe and receive orientation on the CAI program.

Results to Date

Computer-assisted instruction has been used in eastern Kentucky in varying stages for more than a year. In terms of achievement, motivation and general attitude, the results have been very encouraging. In addition to regular elementary students, grades 1-6, various groups have made use of the program.

Adult Basic Education

Computer-assisted instruction has been very effective with adult groups. Plans for the fall program include more extensive utilization in the Adult Basic Education program with two or more centers making use of after school time on the teletype terminals.

Remedial Groups

The 1968 summer programs in the various schools were almost exclusively remedial in nature. Students well below grade level achievement in arithmetic were placed in the program at a success level where they could work comfortably.

Upward Bound

A small group of Upward Bound students worked during the summer on the CAI program. These students were chosen because of low achievement scores in arithmetic as shown by achievement testing. The Upward Bound students made a mean gain of eight months while working on the program for a seven week period.

Dr. Adron Doran, Commissioner Harold Howe III and Charles Foltz, Appalachian Regional Commission, observe Upward Bound students.

Special Education

Computer-assisted-instruction has been very effective with Special Education students enrolled in our University Breckinridge Laboratory School. A group of these students made great strides in arithmetic achievement and were highly motivated by the drill and practice program.

Future Programs

In the fall of 1968, the CAI program in eastern Kentucky will continue with some new features. The concept block idea as described above will be replaced with the strands approach. This should individualize instruction to an even greater extent. For the first time, lessons in logic and problem solving will be available.

Studies are now underway to determine the feasibility of setting up a large scale computer program for eastern Kentucky. These studies include not only the instructional aspect but the handling of administrative functions of the schools as well. With the groundwork laid and the interest generated in this area, the future looks bright concerning computerization of instruction and school administrative functions for eastern Kentucky.

Computer-Assisted Instruction and Multi-Media Instruction at Indiana State University

By

John O. Conaway, David A. Gilman and James L. Fejfar

MOST OF the recent publicity received by computer-assisted instruction and multi-media instruction has been focused on federally funded projects at a few large universities. A quiet approach to research and development in these areas is underway at Indiana State University. This productive effort has thus far subsisted entirely through the resources of interdepartmental education.

Interest and productive effort have developed in the apparently unrelated areas of mathematics, education, radio-television, art, physics, English, library science, and technical drawing. An all-university committee, which has expanded to over thirty representatives of these departments, coordinates and voluntarily has committed part of its time to research and development activities in computer-assisted instruction and multi-media instruction.

Intuitively, it would seem that there are certain advantages for the Indiana State University approach over a funded project at a large university. The multidisciplinary approach has made it possible for members of various departments to work together, compare instructional strategies, and communicate freely about instructional problems. Since Indiana State University emphasizes teacher education, it is possible to educate future teachers in computer-assisted instruction and multi-media instruction principles. Close liaison between the university, its laboratory school, and school systems in the Wabash Valley have made it possible to implement computer-assisted instruction in classroom situations.

The greatest improvement the Indiana State University project has to offer, however, is in terms of its low cost. It is a common misconception that computer-assisted instruction and multi-media instruction research and development are almost prohibitively expensive. The project's success in a variety of activities has been accomplished without a dime of support other than that which has come from resources the university normally provides to its faculty including research computer time.

Summaries of some activities of the project follow.

Multi-Media Instruction in Physics

The Department of Physics at Indiana State University now uses a multi-media system of instruction in its undergraduate introductory courses. The Department of Physics defines multi-media instruction as a cooperative amalgamation of available hard ware and audio-visual aids with varied tea hing methods.

The most pronounced area of success is directly related to the laboratory-recitation parts of the introductory courses. The physics laboratory program has progressed to a nearly total individualized instruction mode. This has been accomplished by utilizing experimental exercises, single concept films, overhead transparencies, sixteen millimeter sound films,

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programmed instruction, ancillary readings, small group interactions, tutorial sessions, audio tapes, and closed circuit television presentations.

Beginning students in introductory physics courses have opportunities to study fundamental concepts considered basic to the understanding of physics through one or more learning modes as they find necessary for success. Certain activities, e.g., small group interactions, serve as synthesis mechanisms for relating experiences of individual students to common conceptual schemes.

Initial analysis of pre-test, post-test data indicates gains in understanding concepts in physics to be highly significant. Furthermore, retention measured one semester after completion of an introductory semester of physics has been determined to be significantly higher than in prior semesters.

Continual evaluation by students, laboratory assistants, graduate students and course directors is maintained in a directed systematic program designed to meet the needs of individual students.

CAI by WVSEC PI Division

A computer-assisted instruction program has been initiated by the Wabash Valley Supplementary Educational Center Programmed Instruction Division. Nathan Z. Bridwell, Director of the PI division, announced that Dr. David Gilman would serve as consultant for CAI along with the regular PI division consultants, Dr. James Rentschler and Dr. Russell Hamm.

Time has been reserved on the ISU 360 Computer. Programs being scheduled for immediate operation are: Math with Lab School elementary pupils; Reading for the Disadvantaged, a program being written by Verona Stewart, Vigo County Reading Consultant; and English being written by Lewis Sego.

Others from the WVSEC community have indicated they also have programs which they wish to validate.

In certain areas of technology, the rapidity of technical and scientific advances has become so great that it is literally impossible to create curricula for student instruction which are not obsolete by the time that they are taught in the schools. Severe shortages of curriculum experts have added to the problem throughout our country.

The experimental program is viewed as an opportunity to teach CAI operations to interested faculty members, to construct and validate programs for student learning centers and to serve as a demonstration center for the WVSEC Programmed Instruction Division.

Computer-Assisted Instruction

The Mathematics Department has developed a drill and practice program which provides learners with a random presentation of exercises. Feedback appropriate to the student's response and an instructional strategy appropriate to his progress are provided by an IBM 1130 computer.

Small solid state computers (called Didactors) are being used to investigate how student errors and misconceptions may best be corrected through feedback. Through new measuring techniques, based on the degree of certainty the learner assigns to his response and on using programming strategies that utilize the correction of student errors, it has been possible to eliminate some of the problems that have previously presented extensive error correction studies.

As a result of research activities encouraged by the committee, members presented research papers at seven meetings of professional organizations and published articles in nine professional journals. Committee members have served as consultants for several major educational equipment and media industries.

The committee has worked closely with the Wabash Valley Supplementary Education Center and has sponsored conferences and workshops of school administrators, teachers, and college professors to provide information and skills in the use of computer-assisted instruction and multi-media instruction. Also, through the cooperation of the Wabash Valley Supplementary Education Center, it has been possible to supplement the classroom activities of students with computer-assisted instruction through the IBM 1130 and small solid state computers.

The committee has often provided speakers to interested faculty groups and local organizations to disseminate information concerning instructional innovations.

In addition to faculty research, the committee has encouraged research in these areas by graduate students. Two master's theses dealing with computer-assisted instruction were published last year, and several student research projects are currently underway. Undergraduate and graduate students in several departments are concerned with and are interested in instructional programming techniques.

The Industrial Education Department has become concerned with hardware development and is constructing a prototype model of a computer-controlled multi-media instructional system. The system consists of carrels which contain a variety of media devices, mediated by a solid state computer.

"THIS ONE'S A REAL CHALLENGE, NO MATTER WHAT YOUR RESPONSE, YOU ARE WRONG..."

ISU Lab School Fourth Graders Learn Through CAI

By James L. Fejfar*

DURING the 1967-68 school year, Indiana State University Laboratory School fourth graders taught by Mrs. JoAnne Toney and Miss Ann Harrison had the opportunity to further develop their skill in multiplication by using the computer in the basement of Holmstedt Hall as a teaching machine.

The IBM 1130 computer, which is designed for scientific research rather than for teaching, was programmed to randomly present the multiplication facts within categories of difficulty to students through its console-typewriter, wait for a student response to be typed, judge the response, and then present a new problem if the answer was correct. If the answer was not correct the computer would type the correct answer and then repeat the question. The process would continue until the learner worked through the program successfully by meeting certain internalized criteria or until the program was terminated by the operator. Words of praise or reprimand could also be presented by the computer after each student response. After each session a report card which summarized student progress was printed.

The theoretical model for this computer-assisted instruction (CAI) system was developed by the author and the computer program was written by Dr. Roger Elliott, now of Texas A&M University, who was then an Assistant Professor of Mathematics at ISU. Undergraduate students, Patricia Elliott and William Stringer (programmers), and Nancy Stone (research assistant), also participated in the project. ISU graduate Joe Crick, now of Terre Haute, served as a consultant during the later stages of the research. Research funds and computer facilities were furnished by ISU.

At the console-typewriter

Initially, a 100-item speed test over the 100 multiplication facts was administered to all of the fourth graders. About half of the pupils were then selected to have supplementary practice with the CAI system. Each student worked at the computer for a 20-minute session once a week for four weeks. During these sessions the students worked a total of 8684 multiplication problems. Of these, 7828 or about 90 per cent were answered correctly. The average number of problems worked per session was 108.4; of these 98 were answered correctly. Student progress in speed and accuracy is shown by Table I.

TABLE I

CAI Progress Chart for 20 Pupils*

Session	Number of Questions	Number of Correct Answers	Percentage
1	2173	1904	87.6
2	2158	1914	88.7
3	2070	1898	91.7
4	2283	2112	92.5

*One student moved from the district and another was absent for an extended period, thus diminishing the CAI group to 18 for subsequent calculations.

JAMES L. FEJFAR, *Associate Professor of Elementary Education, University of Nebraska.*

*Professor Fejfar was an Associate Professor of Mathematics at ISU at the time this research was carried out.

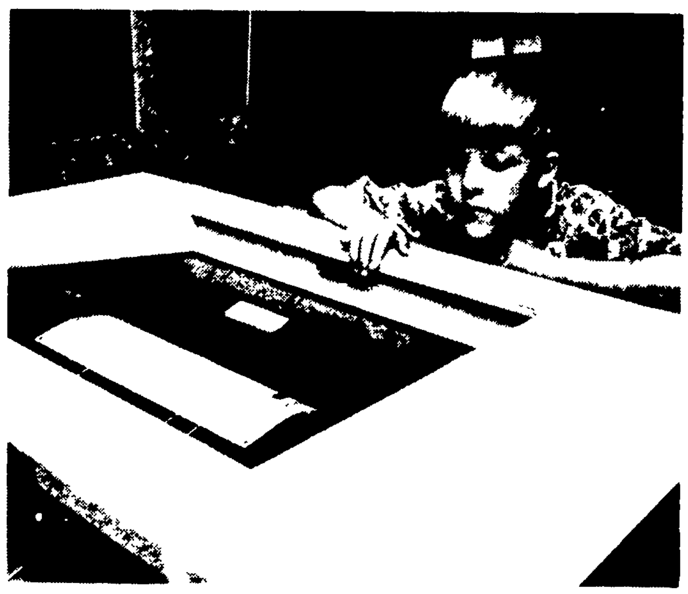
The decline in the number of questions from the first through the third session can probably be attributed to the increased difficulty of the items. It should be noted that by the fourth sessions the students seemed to have less difficulty as evidenced by the increase in both speed and accuracy.

The available students were again tested after the last computer session. As would be expected, both groups increased their skill (see Table II) as measured by the tests, during the November to February interval in which the research took place. The non-computer groups had an initial mean of 45 and a mean of 61 on the last test for an average gain of 16 items on the 100-item test. The means for the computer group were 45.6 and 75.6 for an average gain of 30 items per person. Statistical analysis of the differences between the posttest means (61 and 75.6) yielded a t of 2.36. Since the probability that a t that large would occur by chance is less than .025 and since there is little reason to suspect that other variables caused this gain, it seems reasonable to conclude that the CAI group did learn from the computer.

grade classes stressed concept formation and that the level of recall demanded by the test exceeded the goals of classroom instruction. The comparison of the scores is in no way a disparaging reflection upon the classroom teaching. In fact, just the opposite is true, in the author's opinion. A principal reason for the large gains made by the computer group (almost double that of the others) was that these students were so well grounded in fundamental concepts. The cognitive structure of the students helped them keep on learning.

The youngsters showed great enthusiasm for the computer work. They would volunteer eagerly even during the noon hour and would be reluctant to leave at the end of a teaching session. Part of this interest was due, no doubt, to the aura of the computer. This is a computerized age and the hardware made the students feel "in." The author feels, however, another factor enters in — that of individualization. While a child was at the computer, it was his private tutor. It responded to him and him alone. He did not have to share it with 30 other students as he does his classroom teacher.

Miss Harrison, Mrs. Toney, and Dr. Fejfar



A report card will come from the high speed printer.

TABLE II

Mean Test Scores for Groups

	Pretest	Posttest	Gain
Classroom instruction only (n=17)	45	61	16
CAI and classroom instruction (n=18)	45.6	75.6	30

It should be noted that the classroom mathematics instruction for the fourth

Computers can teach and they do have a coming place in the educational process. It seems, however, that one of their greatest potential uses is that of supplementing classroom instruction by developing skills after the concepts have been developed by the live teacher, as was done here at the Laboratory School.

Computer-Assisted Instruction: Process and Procedure

By James P. Scamman

COMPUTER-ASSISTED instruction (CAI) is entering its second decade. In these few years, the impact of CAI has been widely felt in elementary and secondary schools, higher education institutions, industry, government and the military. Computers are being used for instruction in a wide variety of settings ranging from midtown New York to rural Mississippi.

Educational literature contains numerous articles dealing with the application and impact of CAI. The significant number of leading scientific and educational organizations including papers and symposia on CAI on convention agenda also attests to widespread interest.

Simply stated, computer-assisted instruction utilizes the computer to relieve teachers of routine functions by presenting curriculum to students, accepting and evaluating their responses, determining appropriate next steps based upon those responses, and reporting progress of students to teachers.

The primary objective of most CAI programs is the individualization of instruction. Because of the flexibility of the computer and because of its ability to store large amounts of data, to present it to students as needed, and to evaluate each student's performance, instruction has been individualized to an extent previously impossible.

There are approximately 335 CAI programs of varying types in existence at this time.[1] These programs range from short demonstrations of 30 minutes or less to complete curricula of over 13,500 lessons. CAI terminal sophistication ranges from relatively simple and easily programmed low cost teletypewriter units, such as those to be discussed later in this article, to complex multi-media student terminals, such as those used with the IBM 1500 system. CAI is used for various instructional strategies ranging from drill and practice programs through more complex tutorial programs to a conceptualization of the dialogue mode in which student and computer plan learning sequences together.

This article will describe one CAI system presently employed for drill and practice, its components, their function, and how they interrelate. The system described is the RCA Instructional 70 System[2] which consists of:

1. The hardware, consisting of the computer, student terminals and other devices.
2. The software programs used to run the hardware and manage curriculum.
3. The curriculum to be presented to students.

The Hardware

Hardware comprising the I-70 System consists of the main computer or central processor, input/output devices, storage devices, and remote equipment.

The Central Processing Unit

The central processor manipulates and stores data. The processor has three principal parts: The control unit functions as the controller or manager of the rest of the computer, executing instructions in logical sequences to accomplish a specific

JAMES P. SCAMMAN, *Administrator, Research Coordination, RCA/Instructional Systems.*

[1]News About CAI, Volume III, No. 10, October 1968. (Published by Entelek Incorporated, Newburyport, Mass.)

[2]See Instructional 70 Manuals, RCA Instructional Systems, Palo Alto, California.

task. The arithmetic unit performs addition and subtraction. The core storage holds data waiting to be processed and data which have been processed for transfer to other devices.

The RCA Spectra 70/45 Computer, used in the Instructional 70 System, can store up to 262,000 bytes (characters). The speed of the computer allows it to perform approximately 37,000 five-digit addition problems in less than a second.

Input/Output Devices

Numbers, words and appropriate symbols must be presented in a form that can be accepted by the computer. Several different methods of giving data (input) to the machine and receiving data (output) from it are used.

Input/output devices used by the Instructional 70 System are punch cards similar to standard billing procedures, an electric typewriter for the computer operator, punched paper tape, magnetic tape functioning like an audio tape recorder, magnetic discs which look like phonograph records, and remote terminals or student stations.

Storage

Two types of large capacity storage are used in addition to the core storage found in the central processor. Magnetic discs, capable of storing 7,250,000 characters, are used to store data which must be used (accessed) in a random order. Curriculum material is stored on discs. The magnetic tapes store up to 800 characters per inch and must be read from beginning to end (sequentially). Student records are stored on these tapes.

Remote Devices

The student terminal (instructional station) is a noise-attenuated teletypewriter with special curriculum characters (Figure 1). The terminal sends and receives messages to and from the computer system, displaying data to the student in hard-copy form at approximately 120 words per minute. The student responds on a keyboard. One hundred ninety-two student stations can be connected to the Instructional 70 CAI System.

Figure 1. Student at Instructional Station.

Telephone lines connect the remote portions of the system with the main computer. A line concentrator (a small computer) is used between the central processor and a number of student stations. It receives concentrated data from the central computer and distributes it to each terminal over low-speed telephone lines. Conversely, via high-speed telephone lines, the concentrator condenses the data from several terminals and transmits back to the central processor (Figure 2). Using this system, data can be transmitted over long distances.[3]

The Software

The software system is a series of programs which control the operation of the

[3]The I-70 system successfully transmitted data from the central computer in Palo Alto, California to New York City for several months during 1967-68. In 1968-69 students in Pontiac, Michigan, are taking daily lessons from the Palo Alto computer.

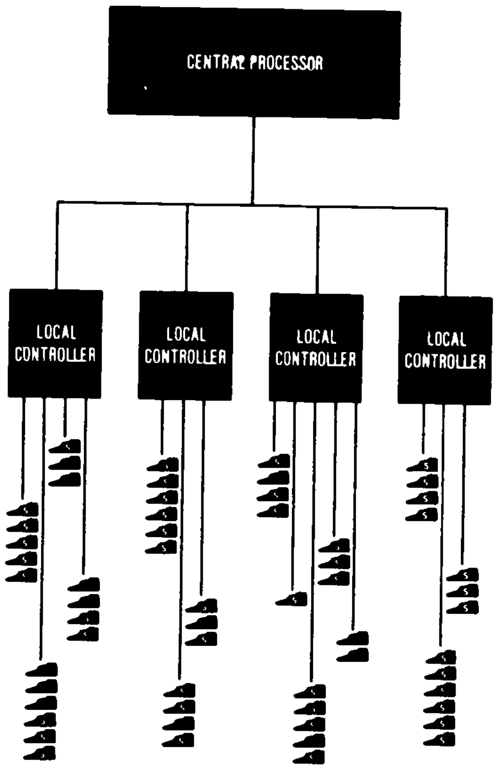


Figure 2.

I-70 System. Each program comprises a series of instructions given to the computer which enables it to carry out a specific function, such as display a question to a student. The software system used to control the Instructional 70 CAI System consists of the procedure program, discussed later, and the operating system. The operating system, which runs the hardware, contains four divisions or subsystems.

Control Monitor

The control monitor subsystem manages the system. It organizes the operating system to control the flow of data within the the whole system. Upon starting CAI processing, the control monitor finds a terminal that is ready to be processed (a student is ready to receive a message from the computer) and transfers control to the interpreter. The control monitor then finds another terminal. Response time is so rapid that each student feels the computer is attending to him individually.

Interpreter

The interpreter subsystem implements the instructions of the course author (procedure program) for presentation of curriculum to a student. It determines the correct instructions in the curriculum procedure to be used for that terminal (student) and executes the instruction. After completion of instruction, the next terminal is selected and executed and so on until a lesson is completed.

Disc Input/Output Control Subsystem

The disc input/output control subsystem (DIOCS) handles all transfers of data to and from the magnetic discs and magnetic tapes. The curriculum is stored on the magnetic disc. When a student signs on a terminal, the computer, through the DIOCS, retrieves the appropriate lesson from the disc and brings it to the core storage area. After a student has responded, DIOCS records his answer on the disc for the daily record and on magnetic tapes for history files.

Communications Input/Output Control Subsystem

The communications input/output control subsystem (CIOCS) handles the transmission of data between remote student stations and the central computer via the line concentrator, verifying accuracy before printing a message to a student or accepting his answer for transmittal to the central processor. The CIOCS transfers the next question or problem to be displayed to a student from the central processor to the line concentrator, with the instruction on how that problem is to be presented and the correct answer. As soon as a student completes his answer, the line concentrator determines if the answer is correct. If it is, the central processor is notified and the next question is displayed. If the answer is incorrect, the student is informed by the line concentrator and appropriate remedial action taken. At the end of a drill, the student is given a record of his performance taking the lesson.

The Curriculum

Curriculum consists of two sections, the curriculum data base and the procedure program. These materials are prepared by curriculum authors, publishers, and teachers.

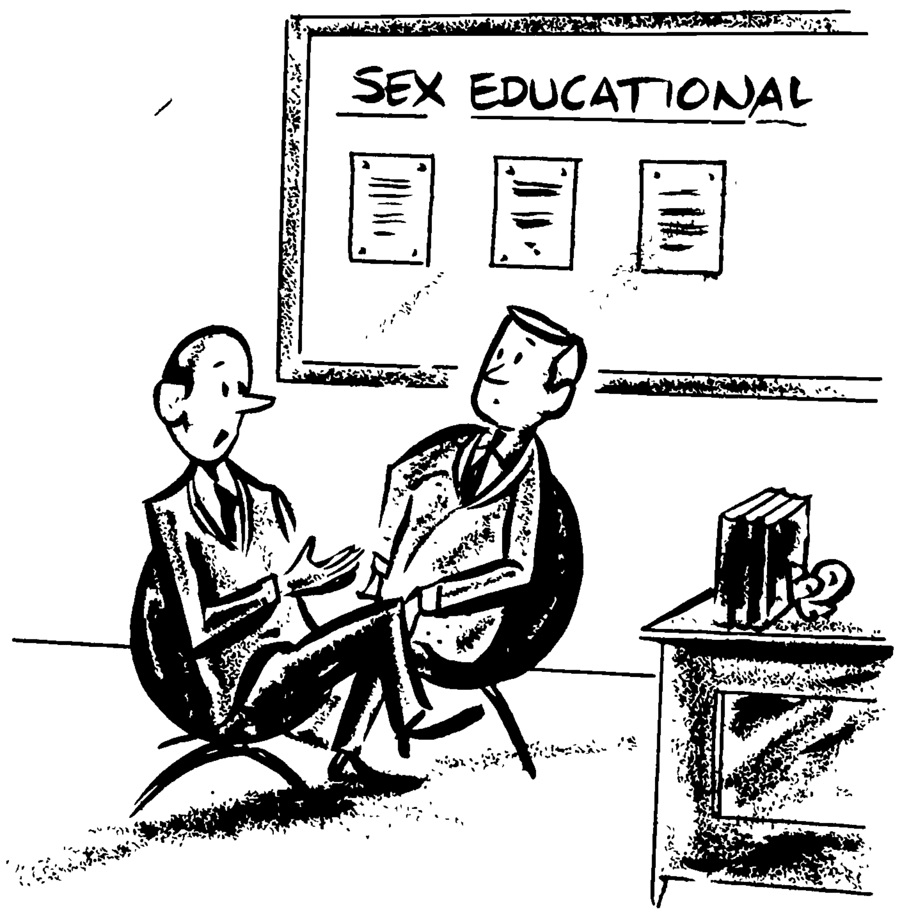
The curriculum data base includes a complete listing of all questions, problems, statements, explanatory materials and other information to be displayed to students. It contains exercises, reviews, tests, and supplementary lessons organized to appropriate grade levels.

The procedure program contains the detail steps to be used in processing the curriculum. It contains instructions to the computer for presenting questions to students, reinforcing correct responses, remedying incorrect ones, and selecting appropriate subsequent lessons.

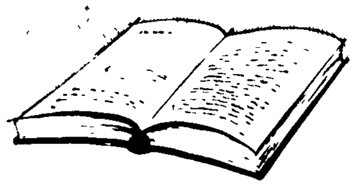
Summary

This article has examined one large scale computer-assisted instructional system. It appears that in another decade, new curricula will be developed that will more closely involve the student in planning and implementing his own learning experiences. CAI will probably be found to be most effective with students at both ends of the exceptionality scales, greatly increasing the ability to teach students individually. Large amounts of information will be made available, easily accessible for students engaged in independent study. As more efficient systems are developed, the costs should diminish, putting CAI within the reach of most schools. Teachers, relieved of much routine work, will be able to concentrate more fully on management of learning experiences. Research on the interaction of man with machines will continue, easing the burden of programming the computer.

The application of CAI in education has just begun. The field is in need of individuals, groups, and institutions capable of and willing to commit resources to the development of new curricula, new hardware and new instructional processes.



"WE GOT OFF THE HOOK, BY LETTING THE COMPUTER DO IT...."



Designing Education for the Future No. 4: 1980, edited by Edgar L. Morphet and David L. Jesser. New York: Citation Press, 1968.

Designing Education for the Future is a series of four reports of a plan and design for shaping our educational program to meet both the long and short term needs of our nation. The program was launched by eight states — Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming — in 1965.

Volume I: Changes in Society — 1980 contains reports by 24 authors in various technical fields who carefully prepared 16 papers setting forth the many important facets which they expect to be projected by 1980.

Volume II: Implications for Education of Prospective Changes in Society has statements of prospective changes in society as viewed by 21 eminent educators who reacted to the 16 papers presented in Volume I.

Volume III: Planning and Effecting Needed Changes in Education presents papers by 30 experts who examined strategies and procedures for implementing changes in individual schools, school systems, and state educational agencies.

Volume IV: Cooperative Planning for Education is a synthesis of and a supplement to the first three conference reports. Its authors concentrated on the most important future educational needs of a changing society and how they may be planned for and effected. This volume is more of a how-to-do-it type of procedure which allows its readers flexibility and alternatives in planning for changes in our educational program. In a review of Volume 4, it is evident that papers presented do not enumerate any theories or ideas that are new in 1969, but the comprehensiveness of its overall plan, the scope of its approach (all levels of education) and the use made of the components of educational administration in setting up guidelines for groups interested in making changes and improvements in our educational program are unique when compared to other attempts to initiate change.

For years we have been lamenting about the lag between the innovation, the acceptance, and the implication of needed changes in our educational programs. This project, initiated by eight western states, gives the entire United States motivation as the states proceed to implement all four reports. The success of this project depends upon total involvement, adequate planning, and dynamic leadership in using our total resources for implementing desirable changes. This program may be very effective in reducing the lag that has been shadowing us for many years.

Planning as presented in this fourth report recognized the inevitability of change and the need for determining its direction. Identifiable problems of the future are exposed and alternate solutions are developed as a procedure for making the most of our resources.

Projects of this type are not models for other states or divisions of government to appropriate and superimpose upon their own area. However, other groups may be very successful in using these four publications for guidelines as they work toward a solution of the educational problems of their area.

The authors of Book 4 have been very successful in making a capstone for the first three books.

This eight state project was financed by funds provided under the Elementary and Secondary Education Act of 1965 (Public Law 89-10, Title V, Sec. 505 and the Sponsoring States).

In the Foreword, Byron W. Hansford

of Colorado, Chairman of the Policy Board, has made a statement which places in capsule form the major objective of this educational design with special reference to Book 4:

"Nearly sixty million people — more than thirty percent of the population of this Nation — are involved today in education as students, teachers, or administrators. Coupled with this involvement to a degree never before experienced in the history of the world is a growing interest and concern throughout our society about education. However, interest, involvement and concern are not sufficient; specific provision must be made for comprehensive planning which not only recognizes the inevitability of change and the need for determining its direction, but also exposes the identifiable problems of the future and develops alternatives for their solution.

"Designing Education For the Future: An Eight-State Project represents a serious attempt to assist people — educators, legislators and lay citizens — to see more clearly how interest, involvement, and concern can be translated into planning, and then into action."

The reviewer recommends that you read the entire series, Books 1, 2, 3, and 4 of **Designing Education for the Future.** The strength of this project is portrayed by the entire series and not by its separate components.

Parmer L. Ewing,
Director of Higher Education,
Office of the Superintendent of Public Instruction, State of Illinois, and
Professor of Educational Administration and Foundations,
Southern Illinois University

ABOUT BOOKS

Professional Student Teaching Programs by Edward C. Merrill, Jr. The Interstate-Printers and Publishers, Inc., 1967.

Professional Student Teaching Programs is a handbook for student teachers, cooperating school personnel, and college and university sponsors.

The book provides some background information on student teaching. Included in this is a criticism of present practices of student teaching, a statement of the purposes of student teaching, and a discussion of several facets of the student teaching program that the student teacher and supervising teacher should know.

The book also includes comments from student teachers and guidelines for beginning student teachers.

The Political World of the High School Teacher by Harmon Keigler, The Center for Advanced Study for Educational Administration, University of Oregon, 1966.

This book is concerned with two levels of discussion. The first level describes the behavior of high school teachers and the second level presents some generalizations about political behavior using teachers as examples.

Also included in the book are discussions on social mobility, political values, job satisfaction, and how they relate to work experience and the political life of the high school teacher. The text also examines the role of the formal organization and how political attitudes play an important part in consensus and conflict in group structures.

The book concludes with some interesting generalizations about the political world of the high school teacher.

Selected Objectives for the English Language Arts by Arnold Lazarus and Rozanne Knudson. Boston: Houghton Mifflin Company.

This book provides a detailed discussion of certain learning objectives for the English language. Some of these objectives include listening, speaking, reading, reasoning, and writing. The text is phrased in such a manner that it explains what English students are expected to learn in grades seven through twelve.

A discussion of the importance of the proper attitude for students to take while learning the various aspects of the English language is also included.

This book can be a useful guide to secondary-school teachers of English, student teachers, supervisors of English, and curriculum directors.

ERIC CLEARING HOUSE ON TEACHER EDUCATION

By Joel L. Burdin

ONE OF our main problems in preparing teachers and other personnel is keeping up with current ideas, information, and research in the field. Another need is to develop means to utilize experts for deciding which information is lacking and then to secure their competence in filling gaps. Neither matter is a simple one, but through the efforts of a new information center on teacher education, the researcher and practitioner in teacher education is getting a better chance to secure comprehensive current, evaluated ideas and information.

The information center is The ERIC Clearinghouse on Teacher Education, part of the ERIC (Educational Resources Information Center) system of the U. S. Office of Education (USOE). Sponsors are The American Association of Colleges for Teacher Education; The National Commission on Teacher Education and Professional Standards, National Education Association (NEA); and the Association for Student Teaching, a department of the NEA.

The Clearinghouse on Teacher Education is part of a national network of information centers, each working in a separate subject area of education, which acquire, abstract, evaluate, index, store, retrieve, and disseminate significant materials in the field. Some of these materials are fed into Central ERIC (USOE), and these and others are used in developing information products disseminated by the clearinghouses themselves or through cooperating educational media.

The Clearinghouse on Teacher Education processes significant information on the pre- and inservice preparation of teachers, supporting school personnel, and teacher educators and initiates state-of-the-arts papers and bibliographies in those areas where information is lacking or needs to be updated. Information is submitted by individuals and groups in the field, and in turn, the materials are processed so that they become available to all, thereby improving person-to-person communications.

Presently the Clearinghouse is receiving and processing hundreds of significant documents. Among the materials it is handling are research documents, newsletters, program descriptions, theoretical papers, published and unpublished conference papers, curriculum guides or studies, addresses, and other useful types of information.

Although the Clearinghouse seeks materials in all areas of teacher education, four priority areas have been identified by its Advisory and Policy Council, whose members include outstanding contributors to the field. The priorities are:

1. The means and methods by which pre- and inservice personnel can secure supervised **practice** in developing skills and insights. Examples include microteaching, simulation, internship, and interaction analysis.
2. The manner in which school personnel can be organized to provide the best services possible, utilizing their unique competencies, knowledge, insights, and interests. This topic includes staff role differentiation and organizational patterns.
3. The kinds of preparation programs which enable teachers to serve the special educational

JOEL L. BURDIN, *Director, ERIC Clearinghouse on Teacher Education.*

NOTE: Dr. Burdin formerly was Associate Professor of Education and Editor, *Teachers College Journal*, Indiana State University.

needs of all the people. Illustrative topics include: (a) preparing to teach in the ghetto, (b) learning to teach bilingual students, and (c) adapting segregated schools to serve integrated student bodies with integrated staffs.

4. The ways in which lifelong teaching competencies can be maintained and extended through productive collaboration of collegiate institutions, local schools, state agencies, and other organizations. Topics include differentiated inservice programs for individuals with varied levels of preparation, responsibility, and competence; and those factors which encourage or inhibit innovative and exemplary practices.

Once information is received, it can be used several ways: (1) It may be abstracted and indexed for publication in **Research in Education** (RIE), the basic abstract journal of the ERIC system. (2) It may be placed in local clearinghouse files for use in preparing standardized materials such as state-of-the-arts papers, monographs, and specialized bibliographies, and in preparing special materials featured in nonclearinghouse media. (3) It may be read to secure names of persons who can be contracted for developing relevant materials or providing those presently available. (4) It may be used for reference purposes within the clearinghouse.

The individual researcher and practitioner can turn to **Research in Education** for information on current developments. He then can: (1) secure microfiche copies or prints readable to the eye through the the ERIC system, (2) secure monographic or bibliographic publications on many topics from the clearinghouse, and (3) use data secured by means noted in "1" or "2" to obtain original documents from their publishers. While the major emphasis of the Clearinghouse on Teacher Education is upon serving **many individuals** through standardized means, some individualized information services can be provided — particularly to those in leadership and dissemination roles which enable them to reach many other researchers and practitioners. The basic criterion is how to serve best the total needs of the education community with resources available.

Since their resources vary and since they have been in operation for different lengths of time, each of the 19 clearinghouses has developed its own policies and procedures for serving individuals; each attempts to serve as many persons as possible. Each clearinghouse has some concern with the preparation of school personnel; only the Clearinghouse on Teacher Education is concerned exclusively with that topic. An effort is made to coordinate the system and to avoid wasteful duplication.

RIE is available in libraries of most higher education institutions, and in libraries of many school systems, foundations, professional organizations, state departments of education, commercial organizations, federal government departments, and other organizations. The domestic cost is $21 a year from the Government Printing Office, Washington, D.C. 20402. RIE provides basic bibliographic data, index terms to identify the nature of a document, informative abstracts, and forms for ordering. It can lead readers to original publications. Documents are available through ERIC in hard copy or microfiche, 4-by-6 inch acetate sheets which can contain up to 62 pages of copy. Documents can be ordered from the ERIC Document Reproduction Service, 4936 Fairmont Ave., Bethesda, Maryland 20014.

Associations, institutions, the government, and individuals are helping to make the dream for an effective information center a reality. The cooperation of all is needed — submitting materials to the Clearinghouse on Teacher Education and other clearinghouses, making suggestions to the staff, publicizing the system to colleagues, and using ERIC services. Two-way cooperation and communication can help the relatively new Clearinghouse on Teacher Education become an integral part of the education community's intention to prepare school personnel for the demands of the times. Sound ideas and information are indispensable tools in such ventures.

Tidings–

DATA EDUCATION

The annual convention of the Society for Data Educators will be held at Portland, Oregon, Hilton Hotel, May 6-9, 1969. Registration forms are available from the convention headquarters.

The Society for Data Educators (SDE) and previously known as the Society for Automation in Business Education (SABE) is now a federation of societies which includes:

SAEH—Society for Automation in English and the Humanities
SAFA—Society for Automation in the Fine Arts
SAPE—Society for Automation in Professional Education
SASM—Society for Automation in Science and Mathematics
SASS—Society for Automation in the Social Sciences.

The broader scope of the new organization is reflected in the journal, **The SABE Journal of Data Education**, formerly called **SABE Data Processor.** Dues remain $5 per year.

* * * * * *

COMPUTERIZED TEACHING

SANTA MONICA, CALIF. — College instructors and secondary school teachers by mid-1970 will have a common tool for the exploration of computer-based teaching.

The National Science Foundation has awarded a $433,000 contract for the further development of an author language called PLANIT by System Development Corporation (SDC), it was announced today.

The new version of PLANIT (Programming LANguage for Interactive Teaching) to be implemented cooperatively with colleges, universities and computer firms will allow simultaneous use by 50 or more students.

By using a typewriter-like terminal, each student will interact independently with a computer that provides instructional problems, records responses, and evaluates progress.

With PLANIT, teachers will be able to easily prepare and try out new instructional material without any specialized knowledge of computers or programming skills. PLANIT is a sophisticated, flexible computer language that is easy to learn from the user's standpoint. It was created at SDC by Dr. Charles H. Frye and Samuel L. Feingold to produce computerized lessons under an earlier NSF grant.

One of the major advantages of PLANIT will be its versatility. The system, which will take two years to develop, will operate on many of the medium- to large-scale computers presently being used in colleges as well as the smaller computers found in some secondary schools. The development of the system will be carried out in such a way as to enable institutions to operate PLANIT on a wide range of computers, with only a small amount of additional programming effort required to make the transition between machines.

In most cases, while the school's computer is normally performing administrative or research data processing activities, it will also be possible for computerized lessons to be in progress.

PLANIT can also be easily expanded to handle classroom management, automated counseling, student and classroom scheduling, and school budget forecasting.

SDC's Education Systems Department, managed by Dr. Harry F. Silberman, will develop the system over a two-year period with Dr. Frye as the project leader.

Representatives from universities, colleges, and computer manufacturing firms attended an all-day briefing on PLANIT at SDC on September 24, 1968. The meeting highlighted details on the proposed PLANIT system and SDC educational researchers demonstrated a prototype version of the system in operation.

Educational institutions and computer

firms desiring additional information either on the PLANIT briefing or special documents describing it may write to Dr. Charles H. Frye, SDC, 2500 Colorado Ave., Santa Monica, Calif. 90406.

* * * * * *

DOCTORATES BY SEX?

According to the U. S. Office of Education, in 1964 men received 89.4% of all the doctorates conferred. Architecture apparently was the only area consisting entirely of men. There were .4% females in Engineering; .9% in Business and Commerce; 1.4% in Physics; 7.2% in Chemistry; and 10% females in History. Humanities is where the women are scoring big. In Languages and Literature, 25% of the new doctorates went to females and almost the same percentage was found in English.

* * * * * *

PUPILS SPEAK TO PUPILS AROUND THE WORLD

(International Tape Exchange)

Now pupils can speak to other pupils around the world according to Ruth Y. Terry, Director of the International Tape Exchange. An 85 page booklet is available with a directory of educational groups interested in exchanging tapes for educational purposes, and names of persons who would like to exchange tapes within the United States and in other countries. For more information write to:

Michigan Audio Visual Association
401 South Fourth Street
Ann Arbor, Michigan 48103

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LEND-A-CAMERA LIBRARY

Hershel B. Harbin, publishing director of **Popular Photography**, believes that if Americans are truly "the leisure-time and recreational kings of the world," then photography, especially for the young people, should become a major part of their "surplus time."

The editors of **Popular Photography** have put into effect a "Lend-A-Camera Library Program." They propose lending cameras just like lending books from the library. This program has had great response throughout the country; retailers are setting up camera libraries with various schools participating in the program.

This program has not been set up to find the "great photographers of tomorrow" but to instill responsibility and create a worthwhile hobby for those who are interested.

For more information on this innovative program, write to:

"Lend-A-Camera Library Program"
Popular Photography
One Park Avenue, New York
New York 10016

* * * * * *

NOVA LEARNING CORPORATION

"Education is a process, not a product," says Eugene R. Howard, President of the new Nova Learning Corporation. The main purpose of this corporation is "the development, publication, and distribution of innovative educational materials and to provide specialized services to schools, school districts, and other organizations desiring to implement innovative educational programs."

There are four publications available during the 1968-69 school year; **Academic Games, Learning Activity Packages ("LearnPacs"), Nova Series on Innovation, and Nova Learning Occasional Papers.** These educational materials are currently in development but will be ready sometime during the 1968-69 school year.

The Nova Learning Corporation also provides Educational Services. Task forces are being created in all parts of the country, to provide, on a systematic basis, a continuous service to organizations wanting to participate in these new programs. At present there are eight task forces being organized:

1. The Task Force on Educational Planning.
2. The Task Force on Academic Games.
3. Small Group Instruction Task Force.
4. Task Force on Instructional Materials Centers.
5. Task Force on Communications.
6. Task Force on Community Relations.
7. Task Force on Continuous Progress.

8. Innovation Evaluation Task Force.

A brochure describing the Nova Learning Corporation is available on request. Write to·

Nova Learning Corporation
440 East Las Olas Blvd.
Fort Lauderdale, Florida 33301
or phone (305) 525-0873

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RESEARCH

Vocational, Technical, and Practical Arts Education, the subject of the October issue of the 1968 *Review of Educational Research,* reviews and comments on the major research and development contributions completed since the last RER special edition six years ago.

Organized by problem areas instead of by subject field, the October RER includes the Social and Philosophical Framework, Manpower Supply and Demand, Career Development, Curriculum Development, Techniques and Modes of Instruction, Organization and Administration, Staffing, and Program Evaluation.

Jerome Moss, Jr., University of Minnesota, Minneapolis, Committee chairman for the current edition, was assisted by John K. Coster, North Carolina State University, Raleigh; Rupert N. Evans, University of Illinois, Urbana; Peter G. Haines, Michigan State University, East Lansing; and Daniel L. Householder, Purdue University, Lafayette, Indiana.

In addition to articles submitted by the above committee, authors consist of Elizabeth M. Ray, Jacob J. Kaufman, and Anne F. Brown, all of Pennsylvania State University, University Park; W. Wesley Tennyson, University of Minnesota; Lloyd J. Phipps, University of Illinois; Allen Lee, Oregon State System of Higher Education, Monmouth; Herbert M. Hamlin, North Carolina State University; Harland E. Samson, University of Wisconsin, Madison; and Loren A. Ihnen, North Carolina State University.

RER, official publication of the American Educational Research Association, summarizes research studies and includes extensive but selected chapter bibliographies in each issue. Established in 1931 and published five times annually, the *Review* emphasizes major topic areas which reflect current developments. Its diversified interdisciplinary readership includes professors of educational research, psychology, anthropology, and statistics; research personnel in private organizations, government, and teacher-training departments of colleges and universities; school administrators; graduate students; libraries.

Single copies are $3.00. Special bulk rates are available to those interested in individual issues.

THAT MAN COLUMBUS

The following is said to have been turned in by a school boy who was told to write a composition on that momentous event which transpired in October, 1492:

One day the king of Spain sent for Columbus and asked: "Can you discover America?"

"Yes," Columbus answered, "if you will give me some boats and sailors."

He got the boats and sailed in the direction where he knew America was. The sailors mutinied and swore there was no such place as America, but finally the pilot came to Columbus and said: "Captain, land is in sight."

When the boat neared the shore, Columbus saw a bunch of natives. "Hey! Hey!" he yelled to them. "Is this America?"

"Yes," they replied.

"Then I suppose you are Indians," Columbus went on.

"Yes," replied the chief, "and you are Christopher Columbus, I take it?"

"I am," said Columbus.

The Indian chief then turned to his fellow savages and said, "The jig is up, guys We're discovered at last!"

—Sunshine Magazine

One Way of Looking At It

By William Van Til

Stereotyping Youth And Negroes

By William Van Til

In the early 1920's, Walter Lippmann popularized the concept of stereotypes in his study of public opinion formation. To put it colloquially, the stereotype is a picture in a person's head concerning the nature of an entire group. The person then reacts to all individuals within the particular group as though each conformed to the picture in the person's head. It is now a long time since the early twenties. Yet stereotyping proceeds as though Lippmann had never written and succeeding generations of opinion analysts had never cautioned us.

Today, stereotyping is particularly prevalent as to two groups in America: youth and Negroes. Introspection concerning both groups appears to have become a form of American industry rivaling the production of automobiles. Though scholars are properly in the forefront in analysis of youth and of Negroes, the new appraisal, like a parlor game, is open to anyone who wishes to play. All that seems to be needed is a strong bias derived perhaps from a favorite columnist or TV personality, or possibly from a traumatic experience broadly generalized upon as representing "their" universal and unvarying way of behavior.

Consequently, we are being told that youth is nihilistic and anarchistic, bent upon overthrowing the Establishment, while without the faintest conception of what to substitute in the Establishment's place. We are simultaneously being told that youth is indifferent to political action and spends its days sniffing flowers and or pot. Such generalizations are often accompanied by reflections on hair, which has become a staple in contemporary conversation. For instance, we are sometimes told that beard wearers are necessarily admirers and imitators of Che and Fidel or that long hair should be equated with hippies. At the other extreme, we are assured that youth is good, noble and idealistic, with these terms then defined by the conservative or liberal inclinations of the speaker.

Similarly, we are told that Negroes want black separatism and are ready to engage in guerilla war against Whitey. Black extremists are being cited as representative of the opinion of the total Negro population. At the other end of the spectrum, some whites still exist who tell us that the Negro is acceptant of what is assumed to be his present goodies in life and that the fuss is the result of "outside agitators." Increasingly less mentioned is the substantial body of Negroes, indeterminate in number, who want just about what the white population wants and who hope to proceed toward middle class status within the framework of integration.

Much m. re sensible dialogue would take place if people could learn that generalizations about groups must be approached with caution. When in doubt, it is safer for educators to assume that within any social group there are varied subgroups than to assume an improbable homogeneity in the group. If we could avoid stereotypes, we could communicate more readily and possibly meet more effectively the pressing problems that confront us.

DR. WILLIAM VAN TIL *is the Coffman Distinguished Professor in Education, Indiana State University.*

Why I Want To Teach

by

Jack McCullough

There is a considerable amount of emphasis today on sophistication. There is also a degree of pressure on each of us to maintain sophistication in all of our attitudes and reasons for any particular aim or action. To do something for a simple, heartfelt reason is considered "corny" and we shy away from it; however Irving Berlin once said, "There is an element of truth in every idea that lasts long enough to be corny." That is the way I feel about my reasons for wanting to teach.

I want to teach because I want to help people. That certainly is not a new idea. It's been around a lot longer than I have but there are continually more people who need help and seemingly less who care about helping.

As a health teacher I feel I could help instill a sense of wholesomeness and regard for well-being in the young people. The high school age of young people is an age where they may still take advantage of good health practices and are just adult enough to begin to choose for themselves those practices they wish to follow. I realize that not every student I contact would benefit from my teaching but there is a great challenge in having the chance to help some to a better basis for life. This is encouraging and the rewards will be great for me if I know I have helped even a small percent.

Secondly, I like young people — even the "bad" ones—and feel it would be most interesting and inspiring to work with them. "When we are out of sympathy with the young," George McDonald said, "then I think our work in this world is over." I hope my work is never over, at least as long as I can breathe, and laugh, and learn. These are my simple reasons for wanting to teach.

Sound Off

Dr. M. Dale Baughman
217 Alumni Center
Indiana State University
Terre Haute, Indiana 47809

Dear Dale:

With my desk piled a foot high all over. I have been sitting here looking at your new Journal, "*Contemporary Education.*" Yes I know, it's been going for forty years under another name. Thanks for sending me a copy.

I read the article on "Cutting Education," lifted from the Washington Post, and noted the squib about Edinburg, Texas, for I continue to remember being there in the Rio Grande Valley (where it is supposed to be warm and sunny) one day when the Mexican help were freezing as they handled radishes with icicles on them.

I read the old master's page — I mean the man with the pipe. "Welcome to the Club, Gentlemen" says what I've been saying quietly to my professor friends; some of these days the professors will have to do what the colored fellow said he was going to have to do, "throw himself on the ignorance of the court."

Thanks again.

Yours truly,
Russe L. Guin, President
The Interstate Printers
and Publishers, Inc.

Dear Editor Baughman:

I wish to thank you for allowing my work to be published in *Contemporary Education*. Certainly I was delighted with the layout and presentation of my article dealing with student teaching and current and compass.

Possibly our paths will cross again this year at some professional meeting. If not, I still will enjoy the communication from you which comes from your writing in the *Journal*. I'll think of you when I listen in on the "buzzin and hum'in."

Thanks again to you and Becky Zeller for your kind attention to my work.

Your friend in Education,
Dr. R. C. Bradley, Associate Professor
North Texas State U., Denton, Texas

Dear Mr. Baughman:

I am a Ph.D. Fellow here at Bowling Green State University, and should like to be better informed of the important work and current contribution of your office in the field of education.

Accordingly, I am requesting to be included in your mailing list, in order to receive regularly your newsletters and general distribution publications.

Cordially,
Richard H. Konkel
Graduate Fellow

Dear Dale Baughman:

I have been reading a number of articles in the November issue of *Contemporary Education* and I am tempted to use the space that I have left on this tape to express my admiration for the way in which it is becoming one of our national journals.

Please give my good greetings and good wishes to Mark Neville who was on our Summer School staff a number of years ago.

With very best wishes, I am

Cordially,
Harl R. Douglas
Lecturer and Consultant and
Dean Emeritus, School of
Education, University of
Colorado

EDITOR'S NOTE: Ben Franklin once wrote, "There are two ways of being happy; we may either diminish our wants, or augment our means—either will do—the result is the same."

We want continued improvement in *Contemporary Education* and we are in the process of augmenting our means. Better facilities, better proofreading and better editing are on the way. Bear with us; *Contemporary Education* will continue to improve.

Your letters of commendation and condemnation are welcome. Through reinforcement we grow; through adversities we grow.

Current and Compass

Means—Ends Confusion

ASK ANY man-on-the-street and he will tell you that the school should teach the 3R's and transmit the cultural heritage. Beyond that, however, no one seems to be able to agree about the role of the school. On every hand public schools are beset by vested interest groups seeking the inclusion of almost every subject one can mention. "We need sex education," "we don't," "teach about communism," "don't you dare," "more driver's education," "that's a frill," and on and on and on. We simply cannot agree on the portion of the educative pie which is exclusively the function of the social institution of the school. Nor can we agree about educative functions of the church and the family. Should, and can, the school be all things to all people? The writer suggests that schools and schoolmen find it convenient to adapt and adjust to the demands placed upon it by society. In this respect the curricular program resembles the chameleon for it is remarkable in its ability to change according to surrounding conditions. For the public schools, George Counts's question of "Dare the schools build a new social order?" has never really been a question for consideration.

As a social institution the schools serve a dynamic, pluralistic, highly complex society. The populace to be served by this one social institution includes the low class as well as the upper class, the poor and the rich, children whose fathers are laborers, those whose fathers are teachers, doctors and lawyers and children who, for all practical aspects in life, have no father. Some children have learned to value education, others tolerate it because of compulsory attendance laws and welfare regulations, while still others openly resent and resist it. The schools serve the rural, the urban and the decaying core. They serve the black, white, brown and yellow. The gifted and the exceptional all sit together in the same classrooms. The "melting-pot" idea still has great significance for public education for it is evident that the social, economic, ability, ethics, racial and religious backgrounds (to name only a few of the more obvious) of the clients of the public school are diverse and varied.

And what does the public school currently offer this diverse school population? A steady bland diet of content — content related to the three R's and our cultural heritage. Somehow we naively assume that essentially the same educational program will meet all these diverse needs and somehow, as if by magic, make self-actualizing citizens of everyone. The "sameness" of which I speak is the sameness afforded through a subject-centered curriculum. No general statement of aims or goals of education is without broad general process goals, such as citizenship and good health. How are these reflected in the curriculum? By the addition of a cognitively oriented course in citizenship. Isn't good citizenship more than cognitive knowledge about government? Isn't it fundamentally a process reflecting certain attitudes and values? How are cognitive understandings —the current emphasis in today's curricula—related to a person's behavior? And a more complex question in such a society as ours is "what knowledge is of the most worth?" The writer submits that so long as we continue to focus on content "ends" we will continue to have confusion and conflict about the role of the school.

Is there a solution to the dilemma? Certainly there is no easy one! But the writer's basic position is that we have been asking the wrong question. Instead of "what knowledge is of the most worth," why not ask "what process or what human understanding is most fundamental to effective citizenship and self-actualization?" We must start to think in terms of "what does the effective citizen do" rather than what does he know.

The following are offered as process and humanistic goals of education:

1. Problem solving abilities—with knowledge increasing so rapidly answers are not enough. Individuals must be taught

to seek answers, to seek solutions to problems or issues as they arise, always bringing to bear the most current and meaningful knowledge available.

2. Data collecting abilities—what are the sources of information? How does one "tap" these sources? What technological advances can be harnessed for the storing and cataloguing of knowledge? These are basic questions of the twenty-first century and toward which we must direct today's students. Heretofore we have attempted essentially to utilize their mir with the storing of information. This must change to an emphasis upon the storing of information about knowledge.

3. Social goals — respect for the dignity and worth of fellow man; regardless of race, creed, social class, etc. Man must come to realize that being different doesn't make one wrong — just different; that man is man because he is born of woman and therefore entitled to value, dignity and worth in the eyes of his fellow man.

4. Self-goals — somehow our educative process must cease to make a good percent of its population feel less than worthy. And emphasis on achievement, competition and content does just that. Millions of students are pushed — out of the public schools annually—becase they didn't conform or compete. These persons typically become social problems. Can we not make them aware of their competencies as members of a society and help them to feel good about these competencies at the same time?

5. Critical thinking goals — if it's printed, is it true? The choices a person must make in a dynamic, pluralistic society are many and complex. Education must include emphasis upon a student's ability to analyze the issue, to evaluate many positions, to make unique decisions about the issue and then apply them to his own life.

What is the end of public education—knowledge? Or is knowledge merely the means by which we are able to fulfill process goals? The latter suggests an alternative to historic approaches. It is not the answer but a beginning for a search—and in searching lies the excitement of learning!

E. Dale Doak,
Associate Professor
College of Education
New Mexico State University

FULLY FOCUSED

Our regular column MOSTLY MISCELLANY which originated In the March, 1967 issue of *The Teachers College Journal* (former name of *Contemporary Education*) is temporarily suspended — this issue only — in order to pay tribute to a departed colleague.

EDWARD C. ROEBER—IN MEMORIAM

There is no miscellany in this month's column. It is meant to be fully focused as was the life and career of EDWARD C. ROEBER whose sudden and unexpected passing on February 8, 1969 cast a cloak of grief and emotional depression over the School of Education which soon overspread the entire university.

Dr. Edward C. Roeber was the R.W. Holmstedt Distinguished Professor of Education at Indiana State University. His professional stature was achieved in counselor education. His forte was service. Humility was his distinctive virtue.

Carlos Romulo once advised his son on the matter of humility: "Son," he admonished, "Always remember the bamboo. The taller it grows the lower it bends." Dr. Roeber was a tall man in his profession and in his person. Humbly he bent low in service to his fellow man. He knew that service to others was a possession which when shared, multiplied and returned a hundred-fold.

M.D.B.

INDIANA STATE UNIVERSITY

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New York Contemporary Theatre Tour .... August 25-August 31

FOR FURTHER INFORMATION WRITE: Dean of Summer Sessions
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